THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

Vol. 65 Thursday, August 14, 1941 No. 1304

PUBLISHED WEEKLY

Subscription Terms (Home and Overseas): 21s. per annum. All Subscriptions are payable in advance.

THE FOUNDRY TRADE JOURNAL
49, Wellington Street, London, W.C.2.
WARTIME ADDRESS
to which all communications should be sent until further notice:—
3, Amersham Road, HIGH WYCOMBE, Bucks.
Telegraphic Address: "Zacatecas, High Wycombe."
Telephone: HIGH WYCOMBE 1792 (3 lines).

OFFICIAL ORGAN OF

The Institute of British Foundrymen

The Institute of Vitreous Enamellers

The Welsh Engineers' and Founders' Association

The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

PRESIDENT: 1940-41

Major R. Miles, M.Eng., Head Wrightson & Company Limited, Thornaby-on-Tees.

LIST OF SECRETARIES—

General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester, 3. London Office: 49, Wellington Street, London, W.C.2.

Birmingham, Coventry and West Midlands: A.A. Timmins, F.I.C., 21-23, St. Paul's Square, Birmingham, 3.

East Midlands: S. A. Horton, "Three," Mostyn Avenue, Littleover, Derby.

Lancashire: A. Boyes, "Rosaville," 7, Kirkstall Road, Davyhulme, Manchester.

London (pro tem.): V. C. Faulkner, 3, Amersham Road, High Wycombe, Bucks.

Middlesbrough (pro tem.): J. K. Smithson, North-Eastern Iron Refining Company, Limited, Stillington, Stockton-on-Tees.

Newcastle-upon-Tyne: C. Lashly, Sir W. G. Armstrong, Whitworth & Company (Ironfounders), Limited, Close Works, Gateshead.

Scottish: J. Bell, 60, St. Enoch Square, Glasgow.

Sheffield: W. Webb, B.Sc., 20, Brookfield Avenue, Swinton, Maxborough, Yorks.

Wales and Monmouth: J. J. McClelland, 12, Clifton Place, Newport.

West Riding of Yorkshire: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.

South Africa: F. C. Williams, Mutual Building, Corner of Harrison and Commissioner Streets, Johannesburg.

Bristol: A. Hares, 167, Ridgeway Road, Fishponds, Bristol.

Burnley: H. Buckley, Ellsmere, Norfolk Avenue, Burnley, Lancs.

East Anglian: J. L. Francis, 12, Glenhurst Avenue, Colchester Road, Ipswich.

Falkirk: T. R. Goodwin, "Viewfield," Falkirk Road, Bonnybridge, Scotland.

Lincoln: E. R. Walter, M.Sc., The Technical College, Lincoln.

The Institute of Vitreous Enamellers

President: Professor J. H. Andrew, D.Sc., Department of Applied Science, The University, St. George's Square, Sheffield.

Chairman: W. H. Whittle, W. H. Whittle, Limited, Eccles, near Manchester.

Hon. Secretary: Dr. G. T. O. Martin, 21-23, St. Paul's Square, Birmingham, 3.

Foundry Trades' Equipment and Supplies Association

President: G. E. France, August's, Limited, Thorn Tree Works, Halifax.

Acting Secretary: Miss L. Cox, 52, Surbiton Hill Park, Surbiton, Surrey.

Welsh Engineers' and Founders' Association

President: W. E. Clement, Morfa Foundry, New Dock, Llanelly.

Secretary: J. D. D. Davis, 9, Royal Metal Exchange, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION

The Registered Office and Laboratories of the B.C.I.R.A. are:—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone; Colmore 4274-4275 *Telegrams: CIRA*
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone: 332

Contents

	PAGE
Floreat Castyngia	103
Three Million New Homes!	103
Labour for Iron and Steel Production	104
Large Cast-iron Ram	104
Random Shots	104
Phosphoric High-Duty Irons	105
Iron and Steel Developments in South Rhodesia	108
Increasing Blast-Furnace Capacities	108
Lectures on Foremanship	108
Moulding Steam Valve Lids for Marine Service	109
Principles and Practice Involved in the Production of Steel Castings	112
Centrifugally-Cast Conveyor Screw	114
The Week's News in Brief	116
Trade Talk	116
Personal	116
Obituary	116
Reports and Dividends	116
New Companies	116
Contracts Open	116
Raw Material Markets	118

Floreat Castyngia

At the beginning of the cricket season, "Castynges," the famous public school, received a challenge from its Board of Governors to play a team to be chosen by them on the Civil Service ground. From the top to the bottom of the school there was an immediate recognition of the necessity of putting up a real good show, as obviously the whole future of "Castynges" depended on the retention of the good will of the Board of Governors, if only on the ground of future endowments. There were plenty of good cricketers in the school and some of the houses—particularly that of Mr. Light—showed real match-playing strength. Yet immediately controversy broke out as to whether masters and day boys should be included in the team; as to who should be captain and whether a professional coach should be employed. The last point was not seriously discussed as it involved the further question of finance, a subject apparently taboo. The representatives of one house, however, had the courage to suggest that some financial help might be forthcoming from the school's booksellers, who always charged the bursar ten per cent. above the published price, but returned this money at the end of the term, providing the school did not buy any foreign textbooks. Realising that such matters were not "cricket," there was no mention on the subject in "The Castyngean," the school magazine. When the great day arrived, not even a scratch team was available so one of the masters, generously paying his fare to London out of his own pocket, apologised to the chairman of the Board of Governors, promising that by next season they would be in a position to place in the field a better team than Steel College, as they had just thought of asking the science master to play. Moreover, he hoped that in a few years' time Castynges would have a better pavilion than Steel College. *Verb sap.*

Three Million New Homes!

The daily Press, possessing more editorial "courage" than ourselves, has announced that 3,000,000 homes will have to be built after the conclusion of hostilities to catch up with the normal programme suspended during the war; to make good enemy depredations; and to house people in newly-created industrial areas. Whilst this figure seems somewhat on the high side to us, the magnitude of the problem and its reaction in the light-castings industry can perhaps be visualised by repeating the old saying that a really heavy snowstorm in the London area would keep Falkirk busy for a fortnight. Each home means internally a minimum of one bath tub, one cooking stove, some type of heating apparatus, one flushing cistern, and externally the usual guttering and drainage systems. Add to these the demands from new blocks of offices, public buildings and hotels and it is obvious that without one single order for replacements or export there is enough work to keep the light-castings section of the industry busy for five years. The natural impatience of some buyers will tend to make them turn to the alternative materials now being used, such as asbestos cement, plastics, weldings and other *ersatz* materials. On the other hand, such a period of intensive commercial production will provide the foundry industry with an unparalleled opportunity to ascertain the optimum properties of its productions and to standardise as near to them as is commercially possible. Moreover, there must be a campaign directed with that high degree of intelligence one has learnt to associate with the commercial exploitation of the basic metals. Previous efforts to popularise cast iron by imitating the "Eat More Fruit" or "Drink More Milk" campaigns were a failure, and probably always will be, because the "man in the street" only indirectly buys cast iron. Efforts of the type of the Building Centre, whilst commendable from many angles—especially as a bureau of information—are static in character, whereas a properly conducted research and development organisation is dynamic. The latter if it had been in existence would not have allowed a certain type of kitchen sink to become regarded as so foolproof and durable that building it into the wall was considered natural, but which time has shown to possess an inherent weakness owing to electrolytic action through contact with the normal materials used in drainage. Not only must an industry know all about its own productions but it must learn everything about the potentialities and weaknesses of those offered in competition. The best gamble which the light-castings industry, in common with other sections of ironfounding, can have during the post-war period is the establishment of an "R. and D." on the lines so successfully conducted by the nickel, copper, aluminium and tin industries. Surely the construction of 3,000,000 homes warrants such an action. Failing the intelligent tackling of the post-war problems, manufacturers of builders' castings will have to meet competition, not only from makers of substitute products, but also from foundries which hitherto have confined their attention to the provision of engineering castings.

Labour for Iron and Steel Production

ESSENTIAL WORK ORDER APPLIED

The Minister of Labour and National Service, after consultation with representatives of workers and employers in the iron and steel industry, has decided to bring the undertakings concerned within the provisions of the Essential Work (General Provisions) Order and in this connection a Special Order was signed on Tuesday. As soon as individual undertakings are scheduled under the Order they will be notified by the Ministry of Labour and National Service and their duties and obligations under the Order explained.

The production of some parts of the industry has to be increased. In some cases additional workers will be required, but in others the necessary increase of production should be possible by suitable re-arrangements and without increased labour. In other sections of the industry production has to be curtailed and workers will become redundant.

The labour supply organisation will deal with undertakings, or separate branches of undertakings, which are already under the Iron and Steel Control. The undertakings affected will be those concerned with:—Iron-ore mining and quarrying; blast furnaces; iron puddling; steel smelting; iron and steel rolling; iron and steel forging; drop forging; iron founding; steel founding; iron and steel tube, pipe and fittings making; iron and steel wire and wire products making; manufacture of steel sheets and tinplate; manufacture of nuts, bolts, rivets, screws and nails; production of ferro alloys; coke ovens attached to iron and steel works; carbon electrodes; scrap collection and distribution.

If, in any case, an undertaking carries on some other activity other than the foregoing, but in such close association therewith that for labour supply purposes they can more conveniently be dealt with together than apart (shell making in steelworks, for example), arrangements should be made with the local committee.

The labour supply organisation will be based on the normal machinery of the Ministry of Labour supplemented by local Executive Committees to be known as Local Labour Supply (Iron and Steel) Committees, with a central co-ordinating Committee to be known as the Central Labour Supply (Iron and Steel) Committee. Each Local Committee will be constituted as follows: An officer of the Ministry of Labour as chairman. Other members: (1) Not more than three representatives of employers and three representatives of workers, nominated by the Ministry of Supply after consultation with organisations of employers and workers concerned; (2) a representative of the area organisation of the Ministry of Supply.

The areas to be covered by local committees will coincide with the civil regions.

Each undertaking must observe the following procedure:—

(1) Current labour requirements, that is, labour that can be engaged forthwith, to be notified to the Local Office of the Ministry of Labour.

(2) Substantial demands for labour expected to arise in the future such as those for bringing new plant into operation, for working additional shifts, etc., to be notified as far in advance as possible to the Local Labour Supply (Iron and Steel) Committee in the area in which the labour will be required; an indication to be given of the approximate date of requirement.

(3) Workers other than those to be employed as managers, salesmen, office clerks and domestic workers, to be engaged only through a Local Office of the Ministry of Labour.

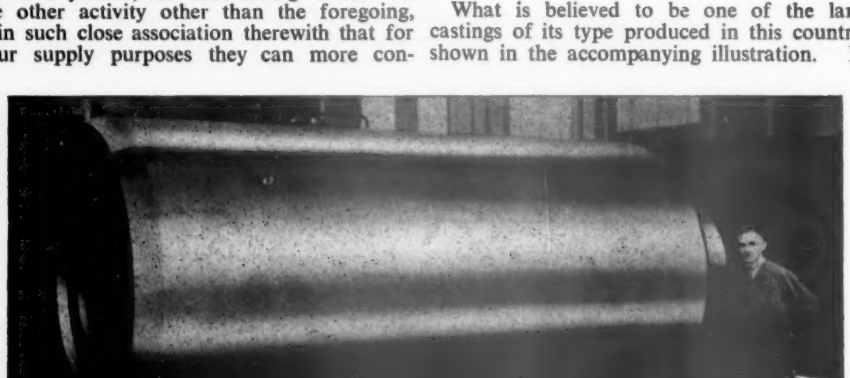
(4) Particulars of all workers surplus to immediate requirements, or likely to become surplus, to be notified to the Local Office of the Ministry of Labour, and the date on which labour is expected to become surplus in the future to be indicated.

(5) Where only a part of the undertaking has been brought under the Iron and Steel Labour Supply Scheme and other parts have been scheduled jointly with it under the Essential Work (General Provisions) Order or a Special Order, surplus workers in the former part may be employed in the latter part provided that particulars are notified to the Local Office of the Ministry of Labour, so that they can be noted as being surplus to the iron and steel industry.

(6) Any appreciable short time working actual or prospective to be reported to the Local Labour Supply Committee with a statement about its cause.

Large Cast-Iron Ram

What is believed to be one of the largest castings of its type produced in this country is shown in the accompanying illustration. It is a hollow cast-iron extrusion-press ram 70 in. dia. and 166 in. long, having a wall thickness of 14 in. and a Brinell hardness of 230. The actual finished weight of this is 55 tons, and the weight of the casting prior to machining was 80 tons. This press ram is a product of the Brightside Foundry & Engineering Company, Limited, Ecclesfield, Sheffield.



HOLLOW CAST-IRON EXTRUSION PRESS RAM.

Heat Consumption in Blast Furnaces

Consumption and thermal investigations on furnace No. 1 at Magnitogorsk, with an internal volume of 1,180 cub. m., made by M. OSSTROUCHOW in "Stal," show that heat consumption is between 2,850 and 2,900 kcal. per metric ton of pig-iron. Fuel is wasted, as there is excessive combustion to CO.

Random Shots

A correspondent from Stockport is very anxious to know, apropos of the recent dissertation on the word "cast," whether the past tense of that word should be "cast" or "casted." "Was the bracket cast yesterday?" or "Was the bracket casted yesterday?" Undoubtedly the bracket was *cast* yesterday. The Shorter Oxford Dictionary does not allow of any alternative and the Shorter Oxford Dictionary is "Marksman's" bible on such matters. Apparently in the good old Elizabethan days the word "casted" was allowable as an adjective instead of the present simple form of "cast," and somewhere amongst the copious works of Mr. Shakespeare an example may be found. (What a holiday task to find it—worse than looking for an onion in a greengrocer's shop!)

* * *

Then follows a more difficult point, for this same correspondent wishes "Marksman" to arbitrate on the vexed question of sand-blast *versus* sand-blasted. At once a snag appears, for the Oxford Dictionary only admits of sand-blast being a noun and not a verb at all. The foundry may have been blasted by lightning or by the Hun the night before but the blasted brackets have still to be treated with sand-blast. It rather looks, then, that to use the word at all as a verb is just another instance of the already innumerable liberties taken with the English language with which the jargon of the foundry abounds, and as such, if a man wishes to say that the castings were sand-blasted yesterday not all the dons in Oxford could say him nay. "Marksman," however, hastens to add that he does not count himself amongst the purists of foundry language and does not claim authoritatively to have busted (no! burst) any special pet theory. He has only humbly broadcast (no, of course, it is not broadcasted in spite of an occasional announcer) a suggestion.

Incidentally, why should anyone want to say that he has sand-blasted the castings when what he really means is shot-blast? It is interesting to note, too, that the Editor invariably overcomes the difficulty by using the verb "to blast-clean."

* * *

"The plants is coming on fine," said Mrs. Malaprop. "My old man dusted 'em all over with that derelict powder the other night."

* * *

"I feel so homesick at the shallow end," complained a superior young swimmer when asked to take her little sister to the swimming bath.

* * *

Some weeks ago the following notice was seen in an hotel lounge: "No cigarettes; no beer; coffee, aspirin and sympathy, 6d."

Then comes "The Iron Age" to this country with a "Fatigue Crack" which reads: "Your South California reporter says that this sign hangs in a Santa Barbara drugstore window: 'Tomato juice, aspirin, black coffee and sympathy, 15 cents'."

Great minds, etc.!

* * *

Just another Cockney newspaper seller's poster:—

"Germans reach the Bug but no flies on Stalin."

* * *

"Why is a coreshop foreman on a Saturday night like a sardine?" is a conundrum suggested by a recent "Times" crossword clue. The answer is: "That they are both canned and tight."

"MARKSMAN."

Phosphoric High-Duty Irons*

By J. G. PEARCE, M.Sc., M.I.Mech.E. (Director, British Cast Iron Research Association)

After the publication by the Institution of Mechanical Engineers of the First Report of the Research Committee on High-Duty Cast Irons for General Engineering Purposes, by J. G. Pearce, M.Sc., M.I.Mech.E., in December, 1938, work was continued on alloyed cast irons in accordance with the Committee's programme. This work was in active progress when the outbreak of war directed the attention of the Committee to those matters within its province which would most assist the national effort. Chief among these was the necessity for making the fullest use of the national resources in phosphoric ores, and hence it was decided to provide engineers with a report on phosphoric irons. The present report is wholly concerned with engineering phosphoric grey cast irons, free from alloying elements, used in the as-cast condition and manufactured in the ordinary way. A further report will be made on alloyed phosphoric high-duty irons.

Introduction

The iron ores most abundantly found in the United Kingdom are phosphoric, and hence the most readily available and cheapest pig and cast irons are the phosphoric irons, which contain up to about 1.8 per cent. of this element for the pig and about 1.4 per cent. for the cast irons. Before the war, by the use in part of imported ores, many grades of pig-iron, covering a wide range of compositions, were commercially available in all phosphorus contents from the low phosphorus hematite irons to those of over 1.5 per cent. phosphorus. Phosphoric irons are comparatively easily melted and poured, and hence are used in the United Kingdom for the cheapest and commonest castings. As a consequence their use tends to be opposed by engineers requiring strong irons. The responsibility for this should be debited, at least in part, to factors other than phosphorus. Phosphoric irons are also used in the highly developed light castings industry for the sections and sizes used in which they are peculiarly well suited, but such castings are not normally submitted to engineering tests.

When the first national specifications for iron castings were drawn up in 1928, it was considered that the lowest grade, grade C, of British Standard Specification No. 321, calling for 9 or 10 tons per sq. in. minimum ultimate tensile stress, could not be met by irons of the highest phosphorus content commercially available unless a measure of control were exercised on composition and melting practice. Where such control is exercised, however, sound and successful engineering castings containing high percentages of phosphorus have been made for many years, and have been found to be of particular value in engine parts requiring resistance to wear. In fact, Tables IV and XI of the First Report show irons respectively containing 0.76 per cent. and 0.87 per cent. phosphorus meeting grade 2 of British Standard Specification No. 786 (1938) (18 tons per sq. in. tensile) and hence qualifying as high-duty irons. There has, nevertheless, in recent years been a very definite movement in the United Kingdom towards the use of very low-phosphorus irons for engineering purposes, and four factors have contributed to this.

A marked development has taken place in high-duty irons made from charges carrying high percentages of steel scrap and also of alloyed irons, both of which have tended towards low phosphorus contents. The rapidly growing and technically advanced automobile industry has required strong and dense castings demanding, on account of their comparatively small size and thin section, a relatively high silicon content, with which, as will be seen below, a low phosphorus content is a necessary concomitant if soundness is to be assured. The development of continuous production systems, especially for large outputs of small castings, has encouraged the use of a standard composition low in phosphorus, adopted to ensure uniformity in foundry practice, although not technically necessary for the whole of the output. By this uniformity, however, the fullest advantages of mechanised plants are realised. These tendencies have undoubtedly influenced practice in the production of larger castings which, as shown below, can be made to yield a dense structure free from shrinkage troubles in spite of a higher phosphorus content, provided their silicon and carbon contents are suitably lowered. Finally, American practice has influenced practice in the United Kingdom, without proper appreciation of the fact that the bulk of foundry pig-iron available in the United States carries less than 0.5 per cent. phosphorus, a higher figure being found chiefly in pig-irons from the Southern furnaces. The war demands the fullest use of home resources, and hence the necessity has arisen for the use of what can conveniently be called phosphoric high-duty irons, involving the adoption of the highest phosphorus contents consistent with specified strengths and with service requirements.

TABLE I.—*Composition Limits for Adequate Strength and Soundness in Phosphoric Cast Irons.*

1.	2.	3.	4.
For grey cast irons of		Maximum percentage of total carbon for reasonable strength should not exceed.	For soundness, the total carbon content given in col. 3 is adequate unless reduced as indicated below.
Silicon, per cent.	Phosphorus, per cent.		
Below 1.5	0.3	3.6	—
	0.6	3.5	—
	0.9	3.4	—
	1.2	3.3	—
1.5	0.3	3.5	—
	0.6	3.4	—
	0.9	3.3	—
	1.2	3.2	—
2.0	0.3	3.3	—
	0.6	3.2	—
	0.9	3.1	—
	1.2	3.0	—
2.5	0.3	3.2	—
	0.6	3.1	2.9
	0.9	3.0	2.9
	1.2	2.9	—
3.0	0.3	3.0	—
	0.6	2.9	2.7
	0.9	2.8	2.7
	1.2	2.7	—

The object of this report is briefly to indicate the limits to which phosphorus can be used with advantage in engineering castings. It is confined to the consideration of plain grey cast iron not specially processed or heat-treated, without alloy additions, and intended for use in the as-cast condition. A further report will be issued on alloyed and specially processed phosphoric high-duty irons.

Effect of Phosphorus on Structure

As indicated elsewhere,* the structure of an ordinary engineering iron consists of a matrix of pearlite or pearlite and ferrite, broken up by graphite flakes. If phosphorus is present in the iron, another structural constituent appears, a microscopically fine conglomerate into one of the two parts of which the phosphorus enters. This constituent, for which the presence of phosphorus in the iron is wholly responsible, is a binary eutectic obtained from what was at solidification a ternary eutectic of γ-iron, iron carbide, and iron phosphide. This loses more or less all of the carbon during the cooling process, the carbide decomposing to iron and graphite, so that as observed under the microscope it is an intimate mixture of iron and iron phosphide. The iron phosphide is hard and brittle, and confers these properties to some extent on the conglomerate into which it enters. By controlling the composition of a phosphoric iron in the manner indicated below, it is possible so to direct the solidification of the phosphide eutectic—which is the last constituent of the melt to solidify—that the most beneficial or least harmful distribution of phosphide results. The phosphide compound is then distributed as a network or honeycomb throughout the matrix.

Phosphorus, like silicon, lowers the capacity of the melt to hold carbon in solution at solidification, so the carbon content of a phosphoric iron made from normal materials is lower than that of an otherwise similar non-phosphoric iron. As the phosphide eutectic melts at a lower temperature than the remainder of the metal, phosphoric irons solidify over a wider range of temperature than the non-phosphoric irons. This aids the foundry process and assists castings to take a sharp impression of the mould, but it also sets up conditions which may create difficulties resulting in shrinkage defects. A common experience in the founding of irons high in silicon, phosphorus, and carbon is their proneness to internal shrinkage. While the difficulty can be considerably offset by skilful running and gating of moulds, the risk can also be very much reduced if certain limits of composition are not exceeded. These have been determined by recent investigations of the British Cast Iron Research Association, and the maintenance of these limits also favours good mechanical properties.

The carbon content, referred to above, that a given cast iron is able to hold in solution at solidification, is known as the eutectic carbon content. To ensure adequate (not necessarily the maximum possible) mechanical strength, the carbon present in an engineering cast iron should never exceed this value, and should preferably be below it. The actual figure is influenced by the amount of silicon and phosphorus present, and Table I gives the carbon content for reasonable strength (equivalent to grade A or grade 1 of the specifications referred to below) for any combination of silicon and phosphorus likely to be met with in engineering cast irons. The carbon content given is 0.2 per cent. below the eutectic carbon figure. For a pure iron-carbon alloy, this is 4.3 per cent. carbon, but is reduced by approximately 0.3 per cent. for each 1 per cent. of silicon or phosphorus present.

So far as internal soundness is concerned, in most combinations of silicon and phosphorus used in engineering castings, the carbon content

* For the text of the First Report, see Proceedings of the Institution of Mechanical Engineers, 1938, vol. 140, p. 133. For the account of the discussion of the First Report in Manchester, see Proceedings, 1940 vol. 143, p. 218. Abstracts appeared in our issues of Dec. 22 and 29, 1938, and July 11, 1940.

* See report on Austenitic and Martensitic Special-Duty Cast Irons, I.Mech.E., 1941, p. 1, and subsequent issues of the Foundry Trade Journal.

Phosphoric High-Duty Irons

given for strength will also ensure soundness. In the higher silicon and phosphorus contents, however, it is desirable, for the sake of soundness, for the carbon content to be slightly below that recommended for reasonable strength; and where these values are lower they are given in col. 4 of Table I. In plain grey engineering castings, however, silicon contents below 1.5 per cent., or more than 2.5 per cent., are seldom required, and the castings with which the report is mainly concerned exclude the extremes of very small and very large sizes.

It will be clear from Table I that small thin castings poured in the ordinary way require relatively high silicon and carbon contents to ensure a grey structure; and, to ensure soundness, phosphorus must be kept low. In larger castings, where lower silicon and carbon contents can be used, the phosphorus can be raised without causing difficulty.

TABLE II.—*Properties of Phosphoric Irons.*

Requirements of British Standard Specifications (B.S.S.) No. 321 (1938) and No. 786 (1938). The test bars are cast respectively in overall lengths of 10, 15, 21, 21, and 27 inches and are tested transversely at spans of 9, 12, 18, 18, and 24 inches respectively.

Test bar diameter, inches.	Main cross-sectional thickness of casting represented, inches.	Grade C of B.S.S. No. 321. U.T.S.,* tons per sq. in.	Grade C of B.S.S. No. 321. T.R.S.,† tons per sq. in.	Grade C of B.S.S. No. 321. Deflexion, inches.	Grade A of B.S.S. No. 321. U.T.S.,* tons per sq. in.	Grade A of B.S.S. No. 321. T.R.S.,† tons per sq. in.	Grade A of B.S.S. No. 321. Deflexion, inches.
0.6	Not exceeding ¾	10	19.9	0.06	12.5	25.1	0.07
0.875	Over ¾ and not exceeding 1¼	10	19.6	0.09	12	24.1	0.10
1.2	Over ¾ and not exceeding 1¼	9	18.9	0.13	11	23.1	0.15
1.6	Over 1¼ and not exceeding 1⅝	9	18.3	0.10	10.5	21.4	0.12
2.1	Over 1⅝	9	17.7	0.14	10	19.6	0.15

Test bar diameter, inches.	Main cross-sectional thickness of casting represented, inches.	Grade 1 of B.S.S. No. 786. U.T.S.,* tons per sq. in.	Grade 1 of B.S.S. No. 786. T.R.S.,† tons per sq. in.	Grade 1 of B.S.S. No. 786. Deflexion, inches.	Grade 2 of B.S.S. No. 786. U.T.S.,* tons per sq. in.	Grade 2 of B.S.S. No. 786. T.R.S.,† tons per sq. in.	Grade 2 of B.S.S. No. 786. Deflexion, inches.
0.6	Not exceeding ¾	16	27	0.07	19	30	0.08
0.875	Over ¾ and not exceeding 1¼	15	25.9	0.11	18	28.9	0.12
1.2	Over ¾ and not exceeding 1¼	14	25.0	0.16	17	28.0	0.17
1.6	Over 1¼ and not exceeding 1⅝	13	24.0	0.13	16	27.0	0.14
2.1	Over 1⅝	12.5	23.6	0.17	15	26.1	0.19

Test bar diameter, inches.	Main cross-sectional thickness of casting represented, inches.	Grade 3 of B.S.S. No. 786. U.T.S.,* tons per sq. in.	Grade 3 of B.S.S. No. 786. T.R.S.,† tons per sq. in.	Grade 3 of B.S.S. No. 786. Deflexion, inches.	Grade 4 B.S.S. No. 786. U.T.S.,* tons per sq. in.	Grade 4 B.S.S. No. 786. T.R.S.,† tons per sq. in.	Grade 4 B.S.S. No. 786. Deflexion, inches.
0.6	Not exceeding ¾	23	34.0	0.09	26	41.0	0.10
0.875	Over ¾ and not exceeding 1¼	22	33.0	0.13	25	39.0	0.14
1.2	Over ¾ and not exceeding 1¼	20	31.0	0.18	23	37.0	0.23
1.6	Over 1¼ and not exceeding 1⅝	19	30.0	0.16	22	35.0	0.18
2.1	Over 1⅝	18	29.1	0.21	21	33.0	0.24

* U.T.S., Minimum ultimate tensile stress. † T.R.S., Minimum ultimate transverse (rupture) stress.

Founding Phosphoric Irons

No special difficulties arise and no additional precautions are required in founding high-duty irons with raised phosphorus contents. Foundries accustomed to the production of phosphoric irons not required to meet strength specifications will find attention to the following points essential, if strength specifications are to be successfully met. Melting practice should be adjusted to give higher melting temperatures, and a higher pouring temperature is required; larger ingates and risers are necessary; a more permeable moulding sand may be required, but additional venting may in some cases prove adequate; some form of control is an advantage, at least in the form of a wedge chill test; and, if possible, chemical, mechanical, and microscopic tests should be carried out.

Effect of Phosphorus on Mechanical Properties at Air Temperatures

In order to appreciate the influence of increasing phosphorus contents on strength for compositions otherwise similar, the general effect of other changes may be briefly reviewed. Within the range of grey irons, mechanical properties—static and dynamic—increase slightly as the section diminishes, and improve with diminishing carbon and silicon contents. The endurance limit in bending fatigue approaches one-half the ultimate tensile stress, and cast iron is relatively insensitive to notch effects and stress-raisers. The effect of dead-annealing is to lower the static properties, but to improve the impact or shock resistance, although these changes diminish for irons of lower carbon and silicon contents. The effect of phosphorus on strength is outlined below, and the conclusions are derived both from results obtained in commercial practice from a wide variety of foundries, and from experimental melts both in crucible and cupola furnaces. They apply to plain cast irons made under controlled conditions, tested and used in the as-cast condition. They do not apply to specially processed, ladle-graphitised (*i.e.*, "inoculated"), alloyed, or heat-treated irons.

(1) In melting ordinary mixtures of pig-iron and scrap, the tensile, transverse, and fatigue strengths and transverse deflection normally increase uniformly as phosphorus increases, to a maximum at about 0.35 per cent. phosphorus. As the phosphorus increases beyond this point, these values uniformly decrease in such a way that the figures for irons containing 0.65 per cent. phosphorus are about equal to those obtained for phosphorus-free material. As the phosphorus increases beyond 0.65 per cent., the figures continue to fall. Evidence for this is considerable, and it is the experience of all the leading industrial countries.

It is not practicable to give figures having general application to the change of properties taking place as a result of variation in phosphorus content, because the properties of a given cast iron depend upon many factors other than the percentage of phosphorus, but the foregoing may be taken as generally applicable, irrespective of the figures for a particular case. In order, however, to indicate the degree of magnitude of the change, the ultimate tensile stress may be expected to improve about 2.5 to 5 per cent. for each 0.1 per cent. of phosphorus added to a non-phosphoric iron, up to a maximum of 0.35 per cent. phosphorus, and then to diminish at a similar rate. The ultimate transverse stress is usually slightly more erratic, and the change is rather less pronounced—about 2 to 4 per cent. higher for each 0.1 per cent. of phosphorus added, up to the same maximum, followed by diminution at the same rate. The change in transverse deflection is of the order of 2 to 4 per cent., the variation occurring in a similar way.

The influence of phosphorus on elastic modulus is not pronounced. The fatigue strength may be expected to follow the tensile strength.

(2) The Brinell hardness number of plain cast iron increases uniformly with increase in phosphorus content, and a rise of about 4 points may be expected for each 0.1 per cent. phosphorus added to a non-phosphoric iron. Increased Brinell hardness normally indicates decreased machinability, but the effect of phosphorus on machinability is still an open question. While the phosphide compound is hard, it is very finely divided and assists in breaking up chips at the point of the tool. The influence on hardness of changes in carbon and silicon content is also marked.

(3) Impact or shock strength diminishes with increase in phosphorus content, and the shock strength of a phosphorus-free iron may be expected to be reduced by about 5 per cent. for each 0.1 per cent. of phosphorus added.

(4) Resistance to wear is influenced by many factors, including structure and composition, soundness, the presence or absence of lubricant, and in particular the part against which the rubbing takes place. Pearlitic structures wear better than ferritic or mixed ferritic-pearlitic structures. Minimum wear is obtained when the difference in hardness between the moving parts is a minimum. When the issue is not complicated by variation in other factors mentioned, it is now generally agreed that, within the limits likely in engineering castings, resistance to wear increases with increasing phosphorus content.

(5) Cast irons are sometimes annealed to facilitate machining. The effect of this process is to transform pearlite into the softer ferrite and there is a consequent decrease in the mechanical properties of cast irons softened to give improved machinability. The phosphide compound, however, is not substantially changed by annealing, and the drop in strength on annealing phosphoric irons is not so pronounced as in the case of non-phosphoric irons. Iron containing 1 per cent. phosphorus shows on dead-annealing about one-half the decrease in strength found in a low-phosphorus iron under similar treatment. The decrease in hardness on annealing is about the same for both high- and low-phosphorus irons.

As stated in item (3) above, the shock or impact strength diminishes as phosphorus increases. Annealing increases the shock strength, and for a given composition the increase is similar for both high- and low-phosphorus irons.

The annealing of castings for stress-relief is not followed by any structural change or change in mechanical properties. Heat treatment of the quench and temper type refines the structure and raises the mechanical properties. Neither should be confused with the softening of castings by annealing for improving machinability.

Effect of Phosphorus on Mechanical Properties at Elevated Temperatures

When engineering grey irons are submitted to high temperatures continuously, or intermittently over long periods, they are liable to internal and external oxidation, leading to

Phosphoric High-Duty Irons

growth and scaling, with a resulting deterioration of mechanical properties. For such conditions, special heat-resisting irons are now available. In some engineering applications, however, it is preferable to use ordinary material and to replace it when necessary, while in others, material has to withstand a limited temperature rise. In general, ordinary engineering grey irons (pearlitic irons) will not be subjected to temperatures exceeding 350 deg. C. phosphorus does not materially influence liability to growth, but tends slightly to improve resistance to scaling.

As the phosphide compound softens and melts at a lower temperature than the remainder of the metal, the behaviour of phosphoric irons at elevated temperatures is of importance. Experiments carried out by the British Cast Iron Research Association on bars loaded in cantilever fashion, while maintained at a temperature of 850 deg. C., show that as the phosphorus content increases the stiffness or rigidity of the metal also increases. Thus, under a given load, bars with 0.4 per cent. phosphorus showed twice the deflection at this temperature compared with bars of 1.1 per cent. phosphorus. At a given load, the deflection at 850 deg. C. was less for a phosphoric iron than for any other cast iron tested, not specifically made as a heat-resisting iron.

Tests on cast iron at elevated temperatures of sufficiently short duration to avoid creep and growth effects, show that within any limits to which structural engineering castings are likely to be submitted, the decrease in strength with temperature is small. These tests show that as temperature rises to about 200 to 300 deg. C. there is a slight fall in strength which is recovered at higher temperatures, so that at about 450 to 500 deg. C. the strength is approximately that at air temperature, after which the strength again falls fairly rapidly. This change is true for tensile strength, hardness, and impact strength. Phosphorus does not appreciably modify this, the strength falling slightly in phosphoric irons up to about 200 to 300 deg. C., then rising to air-temperature level at 400 to 500 deg. C., after which the strength again falls.

Phosphorus does not materially alter the thermal expansion of a cast iron, but slightly lowers the thermal conductivity, the amount being about 0.5 per cent. for each 0.1 per cent. of phosphorus added.

Phosphorus and Corrosion

Ordinary engineering cast irons are, as a general rule, neither intended for nor submitted to conditions involving a high degree of corrosion (for which special irons are now available). They offer very good resistance compared with other ferrous materials not specifically made as corrosion-resisting. Where engineering irons are required to withstand a measure of liability to corrosion by acid, the phosphorus content does not materially affect the resistance.

Use of Phosphoric Irons to Meet B.S. Specifications

British Standard Specifications No. 321 (1938) and No. 786 (1938) specify tensile and transverse strengths, the salient features of the scheduled requirements being given in Table II. For fuller details the Specifications should be consulted. The strengths obtained in terms of composition—total carbon, silicon, and phosphorus—are given in Figs. 1, 2 and 3. Variations in manganese and sulphur met with in engineering castings do not influence these results, provided, as is usually the case, that the manganese content is adequate for the sulphur.

For convenience in use, each diagram refers to a specific range of total carbon contents: Fig. 1, 3.0 to 3.2 per cent.; Fig. 2, 3.2 to 3.4 per cent.; Fig. 3, 3.4 to 3.6 per cent. Each diagram marks the specification which a given silicon and phosphorus content may be expected to meet for a given carbon range. Fig. 1 shows grades 2, 1, and A. Fig. 2 shows grades 2, 1, and A, the fields diminishing as the carbon content increases, Fig. 3 shows grades 1 and A. Compositions outside the A field, but reasonably near to it, may be expected to meet grade C. The left-hand vertical boundary line in each diagram is dotted. It is not implied that irons having a lower silicon content than that indicated by this line cannot or do not meet the appropriate specifications; the bulk of the evidence available relates to silicon contents above that represented by the dotted line.

The diagrams should be used subject to the following precautions:—

(*a*) As indicated above, they apply to plain cast irons made under controlled conditions, tested and used as cast. They do not apply to specially processed ladle-graphitised (*i.e.*, inoculated), alloyed, or heat-treated irons.

(*b*) They are derived from existing data on the strength of standard test bars, 1.2 in. in diameter, tested in accordance with standard conditions. This bar represents castings having a mean cross-sectional thickness between 0.75 in. and 1.125 in. For smaller castings, the appropriate bar, 0.875 in. in diameter, representing castings between 0.375 in. and 0.75 in. in section, may be expected to yield tensile or transverse strengths of 1 ton per sq. in. or, in the high-duty range, of 2 tons per sq. in. in excess of the corresponding figures for the 1.2-in. bar. Conversely, engineering castings represented by the 1.6-in. standard bar, representing castings between 1.125 in. and 1.625 in. section, may be expected to show strengths of a similar order below those of the figures for the 1.2-in. bar. The experience available on the 0.6 in. and the 2.1-in. bars is as yet insufficient to enable results to be expressed generally.

(*c*) Figs. 1, 2, and 3 are based on actual results, and for strength and soundness the carbon figures given in Table I should be followed where these appear to be contradicted by Figs. 1, 2, and 3. As under ordinary manufacturing conditions, high phosphorus contents will not be accompanied by high carbon contents, Fig. 3 will be found less applicable than Figs. 1 and 2.

(*d*) A well-made cast iron falling within the limits of composition given on the diagrams should have the strengths appropriate to the field indicated, but anomalies and discrepancies may be found, as the factors affecting the strength of cast iron are many. If the strength figures obtained are below those anticipated, it will normally be possible, by taking appropriate steps, to correct them. Alloyed, specially processed, or heat-treated irons may be expected to yield figures in excess of those indicated.

(*e*) Strengths vary with silicon and phosphorus contents, increasing as the proportions of these elements fall, and it must not be expected that all the irons in a given field will have the same strength. A slight change in composition from one side of a boundary line to another will not make a marked difference in strength. Furthermore, the grades of cast iron specified do not make a continuous series; there is a gap between grade A and grade 1.

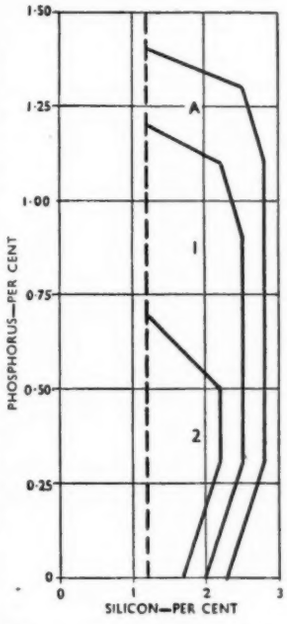


FIG. 1.—TOTAL CARBON 3.0 TO 3.2 PER CENT.

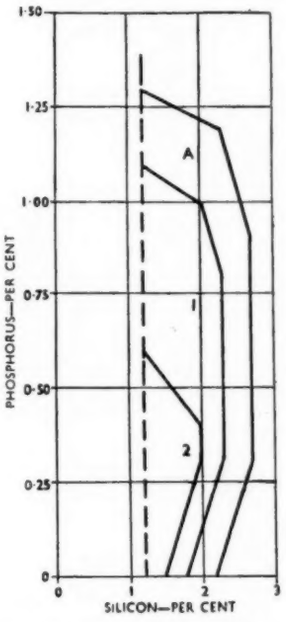


FIG. 2.—TOTAL CARBON 3.2 TO 3.4 PER CENT.

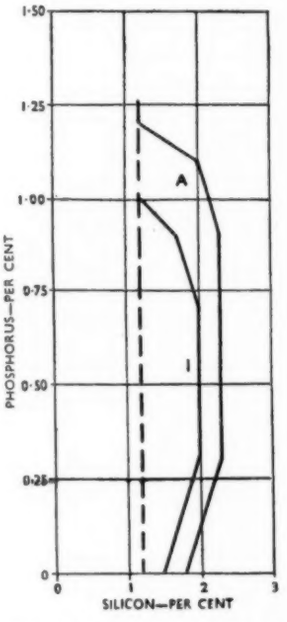


FIG. 3.—TOTAL CARBON 3.4 TO 3.6 PER CENT.

Figs. 1 and 2 show that high-duty cast irons capable of being classified as grade 2 of British Standard Specification No. 786 (1938) can be made, containing phosphorus up to 0.5 to 0.6 per cent. without alloy additions, heat treatment, or special processing. These irons meet the Committee's requirement for high-duty cast irons.

Although reference has been made to earlier investigations, both in this country and abroad, a good deal of experimental work has also been carried out in this field by the staff of the British Cast Iron Research Association, and in particular, use has been made of work done by Mr. L. W. Bolton, A.M.I.MechE., Mr. E. Morgan, M.Sc., Mr. A. J. Nicol Smith, B.Sc., and Mr. A. A. Timmins, with assistance from the chemical, microscopical, and mechanical testing laboratories.

High-Temperature Thermo-Couple

L. LOSANA in "Metallurgica italiana" states that a graphite-carborundum thermo-couple has been successfully applied in practice for the measurement of temperatures up to 1,800 deg. Details are also given of a graphite-tungsten couple.

C

Iron and Steel Developments in South Rhodesia

The South Rhodesian Government has prohibited the pegging and registration of iron and coal claims in the Colony in the immediate future, which is believed to herald an official investigation of the iron and steel manufacturing potentialities of the Colony. In stating the Government's approval of the proposal, the Minister of Mines referred to "the well-known fact that in Southern Rhodesia there are deposits of very high grade iron," and stated that a large iron and steel industry would solve any post-war employment problems.

Referring to this prohibition, "The South African Mining and Engineering Journal" points out that the occurrence of iron ore in Southern Rhodesia is so widespread that its presence must inevitably be of prime importance to the industrial development of the Colony. So far the output of iron for industrial purposes has been mainly ironstone for use as a flux in copper smelting, and the annual output of iron ore has been astonishingly small, totalling 9,823 tons in 1923 and 20,173 tons in 1937. Heavy freights have hitherto militated against the exploitation of Rhodesian ore. While much of the ore is of very high quality, the bigger deposits are far removed from the site of the existing steelworks at Bulawayo, while those in the Bulawayo and adjacent districts have been found to be of a less satisfactory quality.

Present Steelworks

A well-equipped steelworks has already been operating at Bulawayo for some time past, in co-operation with Iscor, and might well form the nucleus of the industry which is apparently envisaged. This enterprise was inaugurated in May, 1937, by Mr. Ronald Paget, a Johannesburg business man who became chairman of the Rhodesian Iron & Steel Works Corporation. The original intention was to produce only shingled iron which would be rolled into bars. The formation of the company, however, was more or less coincident both with the expansion of the Rhodesian gold-mining industry and the development of the copper belt mines, while it was about the same time that the demand for good-quality iron and steel was further stimulated by rearmament. It was decided, therefore, to instal an electric furnace to produce high-class electric steel in all qualities. Such was the initial success of the undertaking that the scope of operations was subsequently extended by the provision of a steel foundry for the manufacture of all classes of steel castings up to 5 tons in weight. This foundry came into full operation in May, 1940.

The Corporation now produces a large proportion of the Colony's requirements for castings, as well as all rolled sections small enough to come within the scope of the works. While the mining industry is the principal customer, the development of other industries has also benefited from the local production of good quality iron and steel. Among articles in regular production at the foundry are tube mill liners, shoes and dies, cans, battery-heads, tappets, such chromium steel castings as tyres and die-rings, and miscellaneous engineering requirements.

In addition to an electric furnace of the Héroult type, the plant of the steelworks includes a 15-cwt. drop stamp for the manufacture of forged steel balls from 2½ in. to 5 in. diameter, and a 5-ton steam hammer for the shingling of iron and forging of steel. Steel for reinforcing work is rolled in the mills, as well as large quantities of sections such as angles and channels.

At present all the steel required is manufactured from a full scrap charge. Whether the future expansion of the Rhodesian iron and steel industry is to be controlled by private enterprise or by the State, the utilisation of local deposits will soon become essential, and prospecting has already been carried out by the Corporation. Unquestionably, the most important future source of ore in the Colony is the formation known locally as "banded ironstone." This is similar in almost every respect to the iron-bearing strata of the Lake Superior region. Mineralogically, the ores are hematites, although both magnetite and limonite are also found. Banded ironstones are also found in the Victoria district, at Iron Mine Hill, between Gwelo and Umvuma, at Que Que, at Mt. Buhwa in the Belingwe district, in the vicinity of Salisbury, south of Bulawayo, and in many other localities. Lateritic ores are numerous, but of much lower grade, and are often very impure. Ores of considerable purity are to be found, however, in the class connected with igneous rocks, which in some cases are very highly titaniferous and in others include very pure magnetite. In the Victoria district magnetite occurs in granite.

Moulding Steam Valve Lids for Marine Service

(*Concluded from page* 111.)

trouble might arise from the presence of gas and blows.

In presenting a Paper of this type an effort was made to ensure that the illustrations given were reliable, and therefore perhaps the amount of head in relation to the casting might be larger than was required for production needs. The only point he desired to make in that connection was that the heads shown in the Paper would produce sound castings. He would rather show an excessive head and be sure the foundry got a good casting, leaving any modification of the head to the individual practical man who cared to experiment.

The remarks of Mr. Phillips about venting having an effect on the size of the head had been fairly well covered by Mr. Hopwood. All the methods shown in the Paper were intended to operate on moulds which were extremely well-vented. It was quite possible, of course, where a mould was not well-vented that it might be advisable to use a larger head in order to try to obtain density. At the same time one felt an effort should be made to start correctly by using as permeable a mould as possible.

Mr. Phillips also raised a query in regard to the method of making up the metal. Due to the number of alloys covered by the Paper, it would be difficult to make any definite assertion except to say in a very general way that so far as he could see the best results were obtained in connection with nickel bronzes when foundrymen made the metal up themselves from virgin material. In the case of material like Monel the alloy they generally received was practically virgin material. When they had to add tin, zinc, etc., he preferred to make up the metal from virgin material because by doing so they received the beneficial effects of the oxidation treatment. If one used an alloy containing an appreciable amount of zinc one did not get the full benefits of an oxidising treatment which was an essential feature of good melting technique in the types of alloys under review.

Finally, he would like to say how gratified he felt in connection with Mr. McManus' excellently written contribution in so far as it fully confirmed his own work and how much he appreciated the trouble Mr. McManus had taken in outlining the results obtained at Cathcart.

Increasing Blast-Furnace Capacities

Additional output from present blast furnaces or the building of additional stacks is necessitated by the United States national defence programme, considers J. P. DOVEL in "Steel." In present circumstances the best economic policy would appear to be the revamping of present blast furnaces in order to increase the output of the great majority of present stacks by 25 to 30 per cent. This has been done in a few cases and is a proved method.

Most blast furnaces are already large enough to get increased production by simply using thin self-replaceable linings, thereby increasing the heating surface above the bosh in many cases as much as 25 per cent., while at the same time reducing flue dust losses to a minimum. It is well known that flue losses often run as high as 500 lbs. per ton of iron produced, especially when furnaces are blown for maximum output.

Another feature that should have serious consideration is the fact that it is unnecessary to blow out a furnace merely because of inwall failings, inasmuch as the inwall can be rebuilt from the outside at a large saving of time and material. The U.S. blast furnace industry as a whole has been loathe to accept this principle. One company which produced 1,400 tons of iron per day on six or seven 13-ft. blast furnaces is producing the same tonnage on two of the old 13-ft. furnaces and two rebuilt 14½-ft. furnaces, all equipped with replaceable linings. The greatly increased area at the top stockline makes a net difference of 27 per cent. in volume above the mantle with a flue dust loss of less than 10 lbs. of metal per ton of iron and a net saving in coke consumption of 400 lbs. per ton of iron produced. This figure has been determined by careful auditing over a period of several years. The same principle has been applied on other furnaces, all of which report similar results.

Many stacks at present have insufficient hot-blast capacity to get maximum tonnage. They can be equipped with thin replaceable linings to secure enlarged volume above the mantle, but some additional blowing power will be required. The output can be increased quickly and at limited expense, thus preventing the use of new material that is needed at present for other purposes and obviating over-building of iron-producing capacity that may not be needed when the emergency is past.

Lectures on Foremanship

The Ministry of Labour and National Service in conjunction with the Board of Education and the Scottish Education Department is organising courses of lectures in foremanship at technical colleges in a considerable number of industrial areas. The establishment of a course in any particular locality will be dependent upon there being sufficient local demand. The lectures will cover the following subjects: (1) General Principles of Foremanship and Supervision; (2) Principles of Production and Planning; (3) Elements of Labour Management; and (4) Costing and Remuneration. The courses will be normally of 72 hours' duration and will usually be given in evening meetings of two hours each, held twice a week. Accordingly, no allowance or expenses will be paid by the Ministry to students. They will, however, not be charged any fees for the course.

It is appreciated that both personality and considerable technical experience are required to make a foreman and that it is impossible to produce one simply by a course of lectures. The intention of the courses is to give the wider background which will be useful to men already possessing these qualifications. On this account only existing foremen and other men with the necessary experience will be accepted and only these should apply for admission to the courses.

Moulding Steam Valve Lids for Marine Service

DISCUSSION AT MANCHESTER CONFERENCE OF Mr. FRANK HUDSON'S PAPER*

Mr. Frank Hudson's Paper entitled "Moulding Steam Valve Lids for Marine Service," which was submitted to the recent Manchester Conference of the Institute of British Foundrymen, was discussed during the proceedings in Session "B" of the Conference. Mr. V. C. Faulkner, past-president, who presided over the session, introduced the discussion by complimenting the author on the practical value of his Paper, and remarking that the Institute was fortunate in having Papers of such interest and scope being presented at the present time when all foundrymen were fully occupied in the war effort. Mr. Hudson introduced his Paper with some additional notes, which are given below, together with a full report of the ensuing discussion and a written contribution by Mr. N. McManus.

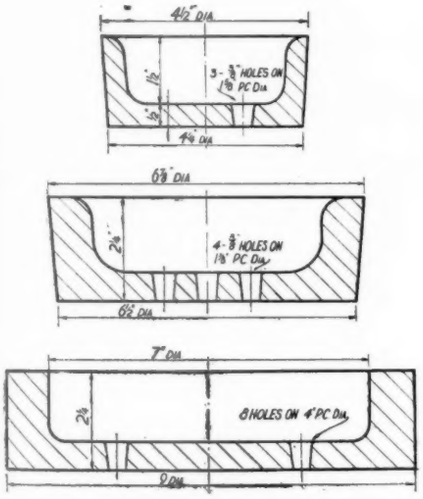


FIG. A.—THREE SIZES OF RUNNER CORES.

AUTHOR'S SUPPLEMENTARY NOTES

Moulding methods covering the application of top pouring to non-ferrous castings are not new. Brisbois and Cartright gave a Paper on the subject in 1938 at the national convention of the American Foundrymen's Association and followed this work by contributing the American Exchange Paper, "Developments of Some Gating and Feeding Methods for High Duty Alloys," to this Institute last year. In view of the good results obtained in the above Papers, it is natural that such methods should be tried out by other foundries, and in the "Iron Age" for May 8 of this year the results obtained by Brisbois and Cartright were amply confirmed by Higgins, metallurgist to the Allis Chalmers Manufacturing Company, of Milwaukee, U.S.A.

The present Paper gives an outline of top pouring methods tried out in several foundries in this country on nickel alloys with very successful results. The production of pressure castings in such alloys in the past has not been an easy matter and the moulding methods suggested have definitely been found materially to assist production. So much so, that it is felt the non-ferrous foundrymen will benefit by studying the effect of top pouring methods on other types of castings and alloys. The principle of direct riser pouring offers many advantages over the more common methods employed for running non-ferrous castings. Probably the outstanding advantage is the greater degree of feeding action obtained due to the head being filled last with the hottest metal and the maintenance of feeding head temperature by virtue of the head being covered by a heated pouring bush or basin. This is well exemplified by comparison of the methods shown in Fig. 6. Many foundrymen will consider the method shown at B satisfactory for the production of gunmetal castings of commercial quality. This may be so, but the fact that such methods do not give satisfactory results with a more difficult alloy suggests scope for improvement and the thought that top pouring methods, as shown at A, would give still better quality gunmetal castings.

It will be found, too, that top pouring methods lessen the sensitivity that different alloys and casting designs exhibit towards feeding head proportions, *i.e.*, the feeding head is generally of a size to compensate for a range of shrinkage wider than that provided for by the more usual methods. This is particularly valuable to-day in view of the variety of alloys being handled in the average brassfoundry.

It might even be suggested that the methods outlined promote a moderate economy in feeding metal and gates and will certainly promote a large economy in the case of certain alloys so far as defective castings are concerned.

Top pouring methods may not be applicable to all types of non-ferrous alloys. Brisbois and Cartright stated that light alloy, aluminium and manganese bronze castings could not be satisfactorily produced due to the tendency to occlude mould gases or entrap dross. On the other hand, Higgins found no difficulty in handling all the normal brasses and bronzes and certainly no difficulties either as regards occluded gas or dross have arisen in connection with nickel, Monel, cupro-nickel, nickel bronze or nickel silver, nor have difficulties been experienced in the work covered by the present Paper. It would therefore seem that the application of top pouring methods to alloys containing appreciable quantities of such elements as aluminium may not be as yet a practical proposition. On the other hand it can be stated that little fear need be anticipated regarding erosion or cutting of the mould surface due to the impact of the metal stream, providing the usual simple precautions are taken.

FIG. B.

FIG. C.

FIGS. B AND C.—SHOWING FORMS AND SIZES OF FEEDING HEADS.

DISCUSSION

The CHAIRMAN read the following written contribution from Mr. N. McManus:—Mr. Hudson is to be congratulated for once again coming forward and adding yet another Paper to the many he has given dealing with non-ferrous foundry practice. Having a special interest in the particular subject, the writer takes pleasure in participating in the discussions, but it is more in the form of a "seconder" or an epilogue with some additional information, confirming much that has been said in the Paper, but it must not be regarded as the only way in producing acceptable valve castings. Coupled with the writer's name must be that of Mr. J. Arnott, well known to most foundrymen, who has materially assisted in the work and whose invaluable aid has made this contribution possible.

It was with extreme interest that the writer read Mr. Hudson's Paper, and noted the methods advocated to produce sound valve castings of the types described, because, quite unknown to him, personal work has been carried out on exactly the same lines with similar valves, but cast with what many consider to be the non-ferrous man's "bogey," namely, "Monel metal." This brings to mind, and it is germane to repeat an excerpt from a Paper given by Mr. J. Dunleavy in the FOUNDRY TRADE JOURNAL of January 9, 1941, which lends colour to this idea:—

"In reviewing the complications and the difficulties in making sound castings in Monel metal, the author has reached the conclusion that the foundryman who attempts the problem without metallurgical assistance is worthy of a

* Foundry Trade Journal of July 17, 1941, pp. 39-41.

Moulding Steam Valve Lids

decoration awarded for conspicuous gallantry in the face of overwhelming odds. Moreover, such a decoration would be awarded posthumously."

There is a good deal of truth in this, but if seriously studied in all its phases—and there are many—much success can be attained. Papers such as Mr. Hudson's go a long way to assist in this direction. From both past and present experience with this method of gating on various castings and valves in particular, the writer unhesitatingly endorses that the methods outlined in the Paper will yield excellent results. Foundrymen are all more or less familiar with the pencil or pop type of gate in one form or another, and much has been published in the technical literature on the subject, but its utility in the non-ferrous foundry is not so well known, more especially when applied to direct riser pouring.

Direct Riser Gates

Fig. A shows three sizes of cores in general use. The 9 in. dia. one, though used as shown, is also in service for other work, in which case it has a core-sand cover attached to the top surface, forming a box with a gate in the centre. Experimenting at first with the small core shown in Fig. A, which then had only two $\frac{3}{8}$ in. dia. holes, the pouring of the moulds was considered too slow and produced an elongated draw in the head of the casting, characteristic of cold metal. The core was then made with three $\frac{3}{8}$ in. dia. holes, which gave a marked improvement in the smaller size of castings.

The medium size core, with four $\frac{3}{8}$ in. dia. holes, proves satisfactory for the general run of work, though at times the holes may have to be slightly increased in diameter. A point may here be made regarding the additional cost of producing the strainer core and the extra moulding entailed, as well as what might be considered the excessive proportion of feeding head when compared with the actual product; nevertheless, the satisfactory outcome more than justified the steps taken to guarantee sound castings for what is considered a very important component.

These runner cores have the following advantages:—

(1) Cleaner metal due to strainer action.

(2) More efficient feeding by having the head filled last with hot metal and the heat retained in the feeding head more effectively, due to being covered by the base of the sand strainer core.

(3) A reasonable economy in metal owing to the absence of any exterior gate, and further the strainer can be practically drained of metal, if care is taken when pouring. Added to this is a marked reduction in the number of rejected castings, when compared with other methods, which also means a reduced melting loss, and, incidentally, a saving in oil fuel.

(4) Monel, as is well known, is one of the difficult metals to cast, owing to its high melting point and very short freezing range, therefore quick and active feeding must take place. The direct riser gating certainly meets these requirements.

However, there is one point to bear in mind. Without good melting practice and control, all the foregoing points are of no avail.

Pintle-Type Valves

A number of valves, mainly the pintle type, had to be made, so the opportunity was taken to make this particular order a trial or test case, and the records of a few of the results have been selected to add to those already shown by Mr. Hudson. The patterns were studied, suitable feeding heads prepared, if not already in stock, and existing runner cores utilised, as shown in Fig. A. All the moulds were dried, so as to introduce one variable at a time. At a later date sand moulds are to be tested under similar conditions.

The form and size of feeding head adopted are clearly shown in Figs. B and C. This type of head, though requiring more metal, is a decided improvement on the more general plain tapered style. Out of 84 castings, eighty were sound and four were rejected on account of shrinkage caused by the feeding head being too small. This pattern is shown in Fig. D (2). Fig. D(3) depicts the same valve cast with the head increased, and defines the depth of shrinkage as being entirely clear of the valve, producing a sound and acceptable product. In passing, and as a matter of interest, this same valve was moulded as if to be made in gunmetal, but poured down the riser with Monel, and is pictured in Fig. D(1). This obviously speaks for itself.

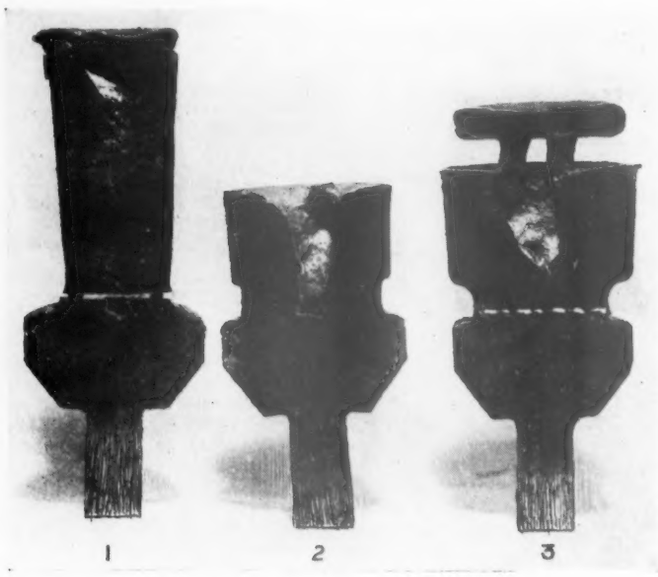


FIG. D.—CASTINGS OBTAINED WITH DIFFERENT FEEDING HEADS.

Heavy Valves

Figs. E and F describe a very different form of valve, and one not easy to produce in Monel; in this case it was decided to cast it upside down as shown, and provide a feeding head to fit over the domed portion of the base, casting it also by direct riser method; here again the problem was solved.

Fig. G outlines a heavy valve seat which was subjected to similar treatment for casting. In place of the circular runner core, a rectangular basin was formed in the cope mould equal to the width of the risers and extending across them in the form of a bridge. Two $\frac{1}{2}$ in. dia. pop gates were placed over each riser, one of which is seen in the photograph. The response was not a single reject. This method has proved highly successful with various sizes of shallow high nickel bronze rings. Care must be taken in all cases to see that the pop gates do not permit the metal when pouring to impinge on the sides of the mould.

FIG. E.—VALVE CAST UPSIDE DOWN BY DIRECT RISER METHOD WITH FEEDING HEAD OVER DOMED PORTION OF BASE.

All the valves are cast with $2\frac{1}{2}$ to 3 per cent. silicon Monel, having a Brinell hardness of 180 and a tensile strength of 37 tons with an elongation of 17 per cent. Small quantities of metal are cast in 60-lb. crucible oil-feed furnaces, and larger amounts in 300-lb. crucible oil-fired tilting furnaces. The castings must be poured hot and quickly to fulfil the requirements of (4), consequently all crucibles and ladles must be thoroughly heated; this is done by means of an oil-fired preheater.

In the case of the 300-lb. furnace, the metal for casting valves is deoxidised with magnesium, while still in the furnace, and then poured into small crucibles, if a number of moulds have to be poured and yet kept within the pouring temperature range. The pouring lip being correspondingly small, also lends itself to clean pouring. When the moulds are larger and few in number the furnace is emptied into the ladle, and deoxidised in the usual manner, before pouring.

As previously mentioned, it is not put forward that the treatment of the subject is the last word in this class of work, nor is it a "cure all" remedy for the many "ills" of the foundry, yet it is a useful "stand by" in many

Moulding Steam Valve Lids

cases when other efforts have failed. It has been largely developed to meet purely jobbing work, which varies greatly both in quantity and size from time to time. Naturally, in the case of repetition work, an intensive study would be made in all directions, and in the case of the scheme herein described, the minimum size of head and runner would have to be settled to give a satisfactory output, before being put into production.

Sand Conditions

MR. HOPWOOD said he had gone pretty thoroughly into the top pouring of all non-ferrous metals, and he agreed with the remarks of Mr. Hudson. With regard to Monel he had had a fair amount of experience of the various methods which had been tried, but the only way in which consistent results could be obtained was either by top running the casting with spray runners, or pouring with a controlled bush. He could bear out the efficiency of that method.

On the question of the erosion of metal dropping on projected portions of sand most foundrymen with a knowledge of sand would

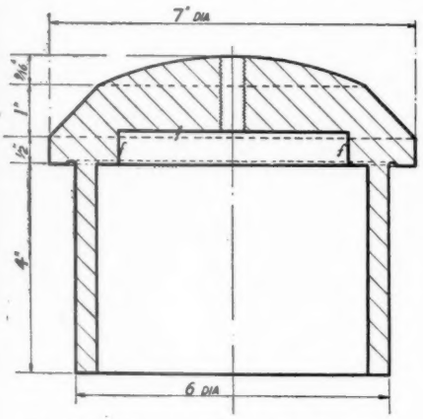


FIG. F.—REVERSED METHOD OF RUNNING VALVE CASTING.

quickly overcome that difficulty. Some people did object to metal dropping on the projecting portions of cores and moulds, but with a little care it could easily be avoided.

The CHAIRMAN, interposing, asked for more information as to the "little care" stated to be necessary.

MR. HOPWOOD observed that it had to be remembered that in the majority of foundries the sand was more or less left to the moulder, and very often, he was sorry to say, the moulds were made from sand which had been used repeatedly. The high temperatures used demanded more refractory sand than was usually to be found in non-ferrous foundries, and an intimate knowledge of mixing was required in order to ensure open permeability and refractoriness.

The CHAIRMAN said that meant there must be proper sand control.

MR. HOPWOOD replied that the management must have a definite idea of the control, as to what sand is being used in the job, otherwise a wrong type of sand is likely to be used and erosion would take place. He had seen that happen through carelessness.

Composition and Casting Temperatures

MR. LONGDEN said the fact that the author had concentrated on a single kind of casting made the Paper more effective in the way of impressing upon the reader the principles involved than would have been the case if a wider range of castings had been dealt with. Could Mr. Hudson tell them what the range of nickel contents was? It was a very wide range that was mentioned, and there might be only 3 per cent. of nickel or as much as 30 or 40 per cent. Some information in that connection would be very useful in correlating the temperatures given in the Paper which were also very wide.

Whilst agreeing with Mr. Hudson that there was not a tremendous amount of published information on the question of the founding of Monel, the Lancashire Branch had had the good fortune to have presented to it a Paper which covered quite a number of ranges of castings of such metal, and they were very grateful to Mr. Phillips for the time he devoted to preparing it. It was very good indeed, and he wished they could get more contributions of that nature.

It was found that a dry-sand mould was far superior to the green-sand mould for the making of castings of any great importance. For instance with cast iron, and certain non-ferrous alloys, dry-sand moulds resisted the movement of the metal after the complete filling of the mould, and if the mould was strong they could get correct filling and a help in securing solidity. He disagreed with the suggestion made by Mr. Hudson in connection with Fig. 8 with regard to the advisability of inserting the Monel in another design of lid, because, as had been pointed out, there should be superheat in the metal to fuse the casting. He would suggest that trouble would be met with gases being occluded or given off from the material if the insert had to be melted. It was not a practical proposition to be safe and to produce a sound casting. One had to remember the presence of studs in all kinds of castings, and if they did not fulfil their functions and fused the cores would move and defective castings would result.

Test-Bars

With regard to test-bars, a number of methods of moulding them were outlined in the final section of the Paper, and a point was made about the stress during shrinkage. The best results would not be obtained if the metal was not allowed to contract freely. There might be stresses set up in the bars due to the resistance of the mould or to the types of heads, and so on. It was possible to produce a test-bar taking the maximum diameter of the grip end as being the same throughout, moulded on end or increasing the diameter of a tapered casting with a head of 50 per cent. It was rather surprising to find, but it was a good fault, such a mass of head metal on these castings. In one case there was nearly 200 per cent. of head metal, and in practice a certain amount of that head metal could be reduced, but not until they were safe and could be assured of it.

Venting to Reduce Head Metal

MR. A. PHILLIPS remarked that one point on the practical side of the manufacture of Monel metal castings had struck him, and he would like to ask if Mr. Hudson had had a similar experience. Mr. Longden had referred to the large amount of head metal. Monel metal castings were similar to certain types of non-ferrous castings, and he had found that a reduction could be made in the head metal by intensive venting. In fact, some people, who saw some of the moulds at their foundry, would think they had gone absolutely mad on the subject of venting. If a free passage from the face of the mould could be created, more especially if the moulds were dry than with green sand, by the use of a wire from the face, it was an advantage though at times it seemed to be a waste of energy. They had found that sounder castings were obtained by that method and he would like Mr. Hudson's opinion on that point.

The CHAIRMAN remarked that he was impressed by what Mr. Phillips had said about venting, which meant an improvement in the permeability. When he had blown smoke through moulds made by the Randupson process he wondered whether that would not be a better solution than intensive venting.

MR. HOPWOOD observed that his experience was that it was essential to use some form of highly permeable sand, coupled with suitable refractoriness, which covered Mr. Phillips' practice as well.

AUTHOR'S REPLY

MR. HUDSON, replying to the discussion, expressed appreciation of the complimentary remarks passed by the various speakers. He would like to endorse Mr. Longden's observations with regard to the presentation of other Papers on the production of individual types of castings, particularly if the writer would select a casting which was giving trouble. A collection of Papers on the production of the more troublesome non-ferrous castings would form a very interesting addition to the Proceedings and a very useful work of reference for every practical foundryman.

FIG. G.—HEAVY VALVE SEAT PRODUCED SIMILAR TO FIG. E.

He was sorry no mention was made of the type of alloys employed, or of any pertinent information as to the method of melting, but that was more or less intentional. The difficulties to-day in presenting a technical Paper were such that one had to think deeply before it was written, otherwise the censor cut it about. This Paper had to receive the approval of the Admiralty before it was allowed to be presented to that Conference, and it was thought wise that no reference should be made to any particular composition employed on His Majesty's ships or other marine vessels. At the same time he felt that those present making this kind of casting would be aware of the type of alloys hinted at in the Paper. It would, however, be no disclosure of national secrets to say the number of alloys employed was fairly wide, ranging from true nickel bronze, containing about 30 to 40 of nickel up to a higher nickel alloy such as Monel. The methods of moulding described in the Paper were equally suitable to any particular alloy in the wide range of compositions employed.

With regard to Mr. Longden's slight criticism of the casting-in method suggested in Fig. 8, he did not want readers to feel that it was intended the whole end of the pintle should be melted off. The idea was to get fusion of the knife edges on the end of the pintle just the same as they would get fusion of a chaplet. Complete melting was not intended, and he would agree that if complete melting took place

(*Concluded on page* 108.)

Principles and Practice Involved in the Production of Steel Castings*

By D. CLARK†

(*Continued from page 93.*)

Green Sand Practice

The important development of green sand moulding throughout the world is a logical sequence arising from large scale production, such as for automobile parts and the like. By this method there is no costly tie-up of box parts, while the necessity for drying stoves or ovens is eliminated. Quite apart, however, from production cost savings, a green sand casting is less prone to hot tearing or cracking, because compared with dry sand practice the mould offers less resistance to the contracting metal, which is therefore freer from strain.

Perhaps the outstanding feature resulting from the introduction of green sand moulding is its enlarging field of application embracing boxless moulding. If a particular design of mould requires reinforcement to withstand the ferrostatic pressure at pouring all that is necessary is to provide slip bands, which may only be of wood positioned immediately before the casting, then removed immediately thereafter and again utilised further along the line when pouring a large number of similar type jobs.

Randupson Process

Linked with boxless moulding is the Randupson cement process, a method which requires the mould to stand for setting purposes any time between 24 and 48 hrs. In a Paper read by Rowe in 1939 before the Institute of British Foundrymen, mention is made of the fact that castings up to 70 tons weight have been produced in this manner, included among which were the stern and stem posts for the French transatlantic liner "Normandie." A point well worth noting in connection with cement moulding is the extremely high permeability of the moulds. To illustrate this, one of the tests made is to take a mould about 2 ft. square, pour into it a quart of water, then cast within 5 mins. Despite the large amount of steam generated, the permeability is such that the steam finds exit readily and without affecting the casting. This process has also been adopted for the casting of ingot moulds.

Cause and Cure of Pinholing

Again referring to green sand work proper, one disability arising from this practice is the greater tendency to pinholing. This must not be confused with the porosity resulting from an unstable or wild condition of the steel as poured.

Whether pinholing arises from immigrant mould gases or from a condition associated with shanking, has been the subject of much controversy. If associated with mould gases then they can only be formed by the dissociation of water vapour. This is difficult to understand, particularly on small castings of thin section which would chill instantly and thus present an impenetrable wall to the ingress of gas. From a limited personal experience of green sand work, it may be said that the problem is more likely to be associated with dirty shanks because from experience of bottom pouring green sand work from a large ladle, no pinhole troubles have been encountered, although porosity traceable to a more or less oxidised condition of the metal has been found.

In the practice of hand shanking, shanks on each heat are used a number of times, and as they are returned to the ladle for a refill, often contain a small amount of metal in the bottom, together with metal particles around the lips. This adherent steel rapidly becomes oxidised, and in turn oxidises the fresh steel poured in. To correct this, the moulder must add aluminium pellets. While perhaps necessary to meet a condition such as this, the use of aluminium in this way is to be deprecated because it is liable to produce embrittlement when tested in tension and to exhibit hard spots on machining. The practice of keeping shanks free from contamination is therefore highly desirable, and if Al must be added it should be carefully introduced into the stream when filling the shank and not when the steel is entering the mould.

Consider now the problem of pinholes on castings of heavier section definitely associated with water vapour. This may be avoided if, in extreme cases, steps are taken to ensure a reduction of the moisture content on the mould faces, by permitting a period of atmospheric drying before closing. It will be obvious that weather conditions play a part in this, since no drying will be possible on days of high humidity. It is then perhaps advisable to skin-dry partially, in an effort to reduce the moisture on the faces by 1 or 2 per cent.

Use of Radiography

The radiographical examination of steel castings, still in its infancy and more of academic than practical interest at present, will yet be of great utility in the steel foundry. In the manufacture of castings to withstand high pressures on marine castings, particularly for naval construction such as stern frames, propeller brackets, and the like, the necessity for ensuring the utmost soundness cannot be over-stated. Certain naval castings are now being examined in this way, but those which are of such section as keep them outside the scope of present-day equipment, still have inspection holes drilled at vital points to examine for cavitation. So that Australia may keep in the van of development in this sphere it is essential that technical institutions be equipped with X-ray apparatus.

Machinery Problems

Referring now to machining problems in the production of steel castings, it seems superfluous to say that sufficient metal should be provided to ensure cleaning up where required. It is generally the practice, where possible, to arrange the surfaces it is intended to machine, in the bottom box part rather than the top. The advisability of this can be understood when it is considered that the major defects disclosed on any casting are generally to be found on the upper surfaces. To offset this the allowances there should be increased.

There are two disabilities castings exhibit which cause the machine shop much concern, namely, burnt-in sand and hard spots. The view has already been expressed that facing sands should be as highly refractory as possible, and the surface finish of the moulds as smooth as possible without interfering with the permeability. If these factors are meticulously watched, burnt-in sand should be the exception, not the rule.

The other machining difficulty mentioned—hard spots—is due exclusively to the indiscriminate and wrongful usage of aluminium. The author does not remember ever having investigated a complaint concerning hard spots on castings, which was not attributable to this. The only safe method of introducing aluminium is either in the furnace or by throwing it into the stream when teeming from the furnace into the ladle after the bottom has been covered with a layer of molten metal. Adding it to the moulds themselves is definitely bad practice and spells defeatism. If it is desired to put it through the furnace then some molten steel should be poured over it first to increase the specific gravity and enable it to sink through the slag readily.

Heat-Treatment

Since castings as removed from the moulds are coarse grained and in a more or less stressed condition, it is necessary to submit them to some form of heat-treatment to produce that degree of refinement dictated by the properties sought. The act of mechanical manipulation either by rolling or forging breaks up the initial cast structure, and as a consequence the subsequent refinement by heat-treatment is facilitated. What, however, in a rolled or forged product has been achieved mechanically must in a casting be done by heat-treatment alone.

Many specifications even in these days of progress call for castings to be annealed, which strictly interpreted involves heating to above the critical point followed by slowly cooling. Such a treatment while fulfilling its function in breaking up the weak cast structure and relieving stress, produces an excessive precipitation of ferrite with a consequent lowering of resistance to impact, particularly at sectional changes. Even admitting, however, the inability of this treatment to develop the highest properties, there are cases where it is necessary, such for instance as castings of intricate design liable to warping troubles if given normal atmospheric cooling from a high temperature.

It is perhaps true to say that many purchasers of castings specify that they shall be annealed simply as a means of safeguarding themselves against being supplied with castings in the untreated condition, and without the knowledge that there are alternative and better treatments. In America it was considered advisable to remove pre-existing misconceptions by defining the terms relating to the heat treatment of castings. The definitions framed are subtended.

Annealing.—This involves the heating of castings above the critical range, holding there for an adequate time, then slowly cooling through the range.

Normalising.—This operation consists of heating the castings above the critical temperature range and holding for a proper period of time, followed by cooling below the range, in still air at ordinary temperatures.

Liquid Quenching.—This operation consists of heating the castings above the critical temperature range, holding for a proper period of time, followed by rapid cooling to a temperature below that range by immersion in a liquid cooling medium.

The basic difference between annealing and normalising is the speed of cooling without introducing quenching in oil or water. The retarded cooling involved in full annealing not only causes some of the micro-constituents to be thrown out of solution, but also produces a gradual coarsening of the grain structure, the degree of coarsening depending upon the rate of cooling. On the other hand, the act of cooling freely in the atmosphere from above the critical range as in normalising, retards crystal growth and prevents an undue separation of the micro-constituents. There is thus produced a more homogeneous structure ensuring in turn enhanced physical properties. As the carbon content increases, however, so do the cooling stresses. To obviate these it may be necessary to introduce a tempering treatment following the normalising.

To ensure the highest physical properties, a quenching treatment in either oil or water is essential. It may or may not be followed by a tempering treatment, depending upon the grade or steel and the service for which the castings are required.

---

* Extracted from the Proceedings of the Australian Institute of Foundrymen.

† Chief Metallurgist, Commonwealth Steel Co. Ltd., Waratah, N.S.W.

Production of Steel Castings

Heat-Treating Plain Carbon Steels

When quenching of castings is mentioned, it is generally assumed that this applies to alloy steels only. Marked improvements can also be shown by quenching carbon steels. In some quarters this practice is considered dangerous, but gradually the fears of those opposed to it are being overcome, and the tonnage of steel castings, not only alloy but carbon grades also, so treated is increasing yearly. Another fear being slowly, but surely, dissipated is that oil provides the best and safest liquid quench. This is definitely not so, as it can be shown that for most carbon and many alloy grades, water is the better medium. When using water, however, particularly on castings with pockets or corners likely to entrap steam, they should be kept moving, so that the steam will be dissipated, otherwise soft areas may result. Castings quenched in oil or water should be withdrawn from the tank while still warm, then, if required to be tempered, charged at once for this purpose.

It is not so long since the treatment of steel castings was performed in a very perfunctory manner, if indeed at all. Perhaps this treatment provides one of the reasons why they were regarded by users with a certain amount of misgiving. The value of accurate heat-treatment is, however, being increasingly realised, and all modern and progressive foundries are equipped with pyrometrically-controlled furnaces, which are just as efficient as those to be found in any modern forging plant. Means for quenching, both water and oil, are also provided so that the full range of heat-treatment necessary for any particular type of steel can be given.

Treatment Following Repairs by Welding

The decision to effect other than minor repairs in this manner without reducing the serviceability of a casting should be made by those having not only a knowledge of how the casting was moulded, but also an appreciation of the conditions under which it will be operating. No casting should be repaired when such repairs are in the least likely to render it unsafe to use.

Due to improved technique which in certain cases may have brought about reductions in weight, repairs of a major order should only be permitted after the most careful consideration. On the other hand, the art of welding has so progressed that in the hands of a first-class operative very extensive repairs can be safely undertaken provided the job is suitably heat-treated afterwards. The intense heat involved in the act of welding produces a certain amount of local stress, the degree depending upon the area and depth of the repair, and in cases where it is desirable to remove such strains, the castings should be heated to such temperature as will not interfere with the properties resulting from the original heat-treatment. Generally, a temperature ranging between 450 and 550 deg. C. can be safely chosen.

The following experimental data (Table II), showing physical properties obtained by submitting castings to standard annealing, normalising and quenching treatment, were prepared for the purpose of this Paper.

Testing

A much-debated point involving considerable discussion at times is how and where test-bars for the determination of physical properties shall be located. On many occasions, where a purchaser has insisted that the test-blocks must be cast integral with and part and parcel of the job itself, foundries, in endeavouring to meet this condition, have jeopardised their product. Before deciding how the test-bars shall be provided, the actual design of the casting itself must be considered. If attaching the block involves the risk of feeding it at the expense of the casting, consideration should be given to pouring it as a separate entity. Stated otherwise, it is the function of the foundry to produce a sound casting and all else should be subordinated to this.

TABLE II.—*Experimental Tests on 1-in. Diameter Cast Bars.*

Heat No.	Composition.	Heat-treatment.	M.S. Tons per sq. in.	Y.P. Tons per sq. in.	E. per cent. on 2 in.	R.A. per cent.	Izod Impact Ft./lbs.
3614	C 0.24, Si 0.34, Mn 1.00, P 0.016, S 0.024	No. 1. Annealed 950 deg. C. Soaked 1 hour and cooled slowly in furnace..	31.4	20.0	31.0	50.0	70.7
		No. 2. Re-heat after annealing, to 850 deg. C. for 1 hour and cooled freely in air	33.7	23.5	32.0	51.4	71.7
		No. 3. Re-heat to 850 deg. C. after annealing and quenched in oil. Tempered at 650 deg. C.	34.1	24.3	32.0	53.0	87.0
3616	C 0.25, Si 0.30, Mn 0.60, P 0.020, S 0.023	Heat treatments were given as above—					
		No. 1	30.2	17.4	29.0	37.6	44.3
		No. 2	31.8	20.2	26.5	32.1	60.3
		No. 3	32.1	22.0	32.5	46.0	60.0
3694	C 0.45, Si 0.58, Mn 0.77, P 0.025, S 0.009	No. 1. Annealed at 950 deg. C. for a hour and cooled slowly in muffle ..	43.1	24.2	20.0	22.2	16.7
		No. 2. Re-heated to 830 deg. C. and cooled freely in air	47.0	29.8	15.5	20.3	27.0
		No. 3. Oil quenched from 830 deg. C. Tempered at 650 deg. C.	46.0	30.2	20.0	33.0	31.3

A scrutiny of these figures indicates the superiority of the normalising and quenching treatments. In every instance there has been an increase not only in yield and ultimate stress, but in Izod impact values also.

Some of the modern specifications for steel castings are so bound up with physical test requirements, static and dynamic, that one has serious doubts as to whether their authors have ever heard that there is such a word in the English language as simplification. There are tensile tests, bend tests, Izod impact tests, Brinell tests, annealing lug tests, dropping tests, ringing tests, hydraulic tests, and still there seems no end. They would appear to have been given birth in an environment of doubt and apprehension.

In the assessment of a casting, as for example for railway or general engineering purposes, there are three essentials:—(*a*) Is it sound?; (*b*) has it the required strength?; and (*c*) is it free from brittleness?

In so far as soundness is concerned, this can in many cases be judged by a skilled person from careful visual examination combined with a knowledge of how the casting was moulded. Referring, however, to its physical properties, the provision and preparation of tensile tests, bend tests, and Izod impact tests cost money, and it is questionable if this expenditure can always be justified. In making this statement it is by no means intended to convey the impression that testing is unnecessary, but rather that cheaper and other equally effective means of assessment should be sought.

Tensile and bend tests are intended solely to determine strength and ductility statically, but give no indication of shock resistance. On the other hand, the Izod is a dynamic test providing a measure of the capacity of a steel to withstand impact at an abrupt change in section and gives a truer indication of ductility than can any interpretation of elongation and reduction in area values obtained from the tensile test.

In illustration of this there may be cited the case recently reported in a British technical journal. A number of 20-in. dia. forged crankshafts failed in service in England. These forgings all showed very excellent properties judged by tensile tests, but extremely low Izod results. In respect of elongation and reduction of area, the values were of the high order of 40 per cent. and 60 per cent. respectively, while the Izod impact tests were only 3 ft.-lbs. Despite the apparently high ductility of these shafts viewed from the aspect of the tensile tests, the fact remains that the steel was abnormally brittle under impact. Examination by the microscope revealed the reason to be that the pearlite had become globularised as a result of prolonged heating at a low temperature.

The same anomalies with respect to steel castings have come before the notice of the author from time to time. A few years ago the opportunity presented itself of examining the product of a well-known foundry abroad. Tensile test-bars and bends were proudly exhibited. These, on the face of it, seemed to indicate that this foundry was perhaps a little ahead of its fellows. Upon inquiry as to the shock resisting qualities of the castings, it was learned that they had never troubled about Izod impact tests, the tensile and bends were so good. It was arranged, however, that an impact test should be prepared from one of their pet bend tests. This produced figures so low that they were shaken out of their complacency. Upon examination under the microscope, the reason was at once revealed. The grain structure proved to be very coarse with the ferrite existing in massive form—all the result of an exaggerated annealing.

Tensile and bend tests are not, therefore, always a reliable guide as to the true physical properties of a casting and, on that account, in very many instances not worth the money spent on them. In the author's view, all that is necessary is to take a Brinell test to assess the strength, provide annealing lugs which, when broken off, will disclose the fracture, indicating to the skilled observer the degree of resistance to impact, and as a final check-up, if necessary, an examination under the microscope. With modern equipment, this latter investigation, including preparation of the specimen, need only take a few minutes.

If this suggestion is regarded as too drastic, then an alternative which should stifle criticism would be to provide an Izod impact test only, and Brinell the same bar for the purpose of obtaining tons per square inch tensile. The purchaser would thus be furnished with the tensile stress of the casting and its resistance to shock. These factors represent all that matter.

Conclusions

Having now covered the various phases in the production of steel castings, the question may be posed, "How can their place in the general scheme of things be consolidated and their sphere of operation enlarged?" The following seem fitly to supply the answers:—

(1) To appreciate the fact that no casting is better than the steel from which it is made, and that it is equally necessary (if indeed not more

Production of Steel Castings

so) for castings as for the most important ingot for forging—to exercise proper care in producing the steel.

(2) To select a suitable grade of sand having in mind what it has to do. This can be best done by instituting proper sand-control involving routine testing.

(3) Nowadays of intense competition, where the constant drive is for greater output per man-machine-hour, it is well to remember that in any phase of life the race is not always to the swiftest, and that the first requirement in any foundry is to avoid having to make a job twice. This involves careful planning beforehand, as to how the casting should be moulded, run, and fed.

(4) To take advantage of modern developments in heat-treatment and realise the fundamental and beneficial change in the physical structure that takes place when castings are given normalising or a quench-tempering treatment instead of the annealing so frequently prescribed in a large number of present-day specifications.

Finally, to remember that there is still considerable prejudice to overcome before castings will be accepted with the same confidence as forged or rolled products, and it is only by intensive and intelligent application and paying the strictest attention to all phases of production from steelmaking to final inspection that the product of the foundry will be looked upon as favourably as that of the forge, and as something which cannot be produced more efficiently by any other means. To this end, the trade schools and technical colleges can greatly assist.

In any country in process of development it is of paramount importance that technical education be of the highest possible standard, since no State can ever become industrially great if facilities for the technical training of its youth are permitted to lag behind those of competing nations. Australia has just reason to be proud of its progress thus far, but there must be no resting period; there is yet much to do, and while not wishing to belittle the cultural or classic phases of education, they should, until our industrial position is amply consolidated, be subordinated to the technical side.

Those controlling technical education are performing a most important national service, and entitled to receive every possible encouragement. Their enthusiasm must not be damped either by Governments withholding the wherewithal to install and equip adequately and completely the technical institutions, or by industrialists failing to inculcate in their young men a desire to take advantage of the facilities provided.

The modern executive owes it to the rising generation to see that they have ample means of equipping themselves adequately for their tasks, so that they may have every opportunity of proving themselves worthy inheritants of the legacy that in the fullness of time will be theirs.

DISCUSSION

MR. EDGERTON recalled the fact that Mr. Clark's company was responsible for the cast crankshaft on the M.V. "Port Fremantle," a casting which had been in use for five years, and as far as he was aware, the only cast crankshaft on the high seas. This, approved by Lloyd's, was a notable achievement. He could not altogether agree that the ideal metal for castings was also the ideal metal for ingots. Mr. Clark had stressed the view that the most fluid metal at the lowest possible temperature was the ideal metal for a casting. Fluidity was not the essential property of forging metal; rather a freedom from impurities and inclusions was desired.

With forging ingots every possible condition likely to produce sound steel was utilised, viz.: smooth cast iron moulds, with fluted sides and graphited surfaces tapered to a wide top, bricked feeding heads, careful pouring temperature, and rate of pouring. Conditions such as these were not possible with castings, and the ingenuity which foundrymen exercised to pour sound castings under difficult conditions compelled his admiration.

To counter the effects of slight moisture in sand moulds, he had found it necessary to increase the silicon and aluminium contents of steel beyond that required for perfectly killed metal suitable for ingots.

He suggested that there was a possible similarity between the tearing of ingots and the tearing of castings. Two conditions caused tearing of ingots—hot pouring and roughness of ingot moulds. These troubles appeared to be increased when pouring alloy steels. He considered that when freezing, the steel reached a "mushy" stage in which it had very little strength, and it was imperative to permit easy contraction.

MR. MOSS asked what the lecturer meant by high quality steel. Did he judge it by chemical analysis or physical tests? Referring to the use of aluminium, he had found no loss of ductility even with excessive doses placed in the ladle, and was inclined to attribute it, when present, to an incorrect ratio between the sulphur and manganese. He suggested that scabbing may be caused by the low permeability of backing sand, forcing gases back into the mould and blowing some facing sand. The idea that "tops" are sucked down is a myth. Finally he drew attention to the fact that with all metals during solidification there is a point when their strength is zero, and asked, "Can the addition of alloys alter this?"

Author's Reply

MR. CLARK, speaking in reference to the cast steel crankshaft for the M.V. "Port Fremantle," said it was true to say that it represented the only casting for such a purpose that had been accepted by Lloyd's for any vessel built under their supervision, but there was another ship in the world also that had a cast steel crankshaft—the "Gulfpride," an American vessel built under American rules. Castings were already used for stern frames, propeller brackets, and the like, and there seemed no reason for the deep-rooted conservatism which prevented a more liberal extension of castings to include such as suitably designed crankshafts.

Referring to the ideal metal for ingots and castings, the lecturer joined issue with Mr. Edgerton when he said that "fluidity was not the essential property of forging metal; rather a freedom from impurities and inclusions was desired." It was immaterial whether the metal was required for use in a metal ingot mould or a sand casting; the highest fluidity at the lowest temperature suitable for the particular purpose was always desirable. The higher the fluidity the greater would be the freedom from impurities and inclusions other than those in solution, because they could be rendered more mobile and had greater opportunity for floating up into the discard region. Conversely, if the metal was sluggish, although it might be hot enough, impurities would tend to be entrapped in the usable part of the ingot which might not therefore pass a cleanliness test. He agreed with Mr. Edgerton that comparing sand castings with ingots in iron moulds, it was generally necessary to add more silicon and aluminium to ensure a steel quiet enough to lie in sand.

Mr. Edgerton had suggested there was a possible similarity between the tearing of ingots and castings, but this surely could only apply to transverse cracking. A transversely cracked ingot is not necessarily a sign of hot pouring, but rather that the ingot was bound somewhere in a lengthwise direction and not therefore free to respond to movement during contraction. Hot or too fast pouring on the other hand produced the more insidious longitudinal type of crack, which may extend the full length of the ingot. In alloy steels, particularly of the air-hardening variety, they were apt to be so deep as to render an ingot unfit and dangerous to use unless the cracks are removed beyond all shadow of doubt by dressing.

Replying to Mr. Moss, MR. CLARK said he judged the quality of steel by physical tests. There are many phases of steelmaking determining the quality of a heat of steel much more important than the requisition of absurdly low percentages for sulphur and phosphorus. For work of the highest importance, say for aircraft or ordnance—in addition to the usual physical tests, the steel is also generally examined microscopically for cleanliness. Even this, however, may be overdone. What is more important perhaps is not altogether the number of non-metallic inclusions present, but their character, size, and shape.

Mr. Moss also referred to excessive doses of aluminium placed in the ladle, and stated he had found no loss in ductility. In his (the lecturer's) experience loss of ductility attributed to aluminium was not due to excess, within reason of course, but to the manner in which it was added to the ladle. That large amounts of aluminium do not produce brittleness can be seen from the tests obtainable from the aluminium bearing series of steels used for nitriding which actually contain 0.90 to 1.30 per cent. aluminium and exhibit high degrees of ductility when suitably heat-treated.

In heat-resisting steels, the two alloys mostly employed are chromium and nickel, the former to give resistance to scaling and the latter added strength at high temperatures. If this is accepted then it must also be accepted that any steel of such a combination would have a higher "zero" strength than a carbon steel. In suggesting that one cause of scabbing is too low permeability backing sand, Mr. Moss mentioned a point with which the lecturer was in complete agreement.

Centrifugally-Cast Conveyor Screw

A notable achievement in centrifugal casting has been brought to our notice by The Duraloy Company, Scottdale, Pa., who for years have been manufacturing centrifugally-cast tubing in sizes ranging from 2½ to 16½ in. O.D. The firm has also engaged in the construction of screw conveyors which were made by first casting a tube and then welding the flights to it. At a first glance it did not appear possible to produce the whole job by centrifugal casting,

CENTRIFUGALLY-CAST CONVEYOR SCREW.

but after many trials a technique was evolved which enables the flights to be centrifugally cast integral with the tube, thus eliminating the welding. The makers have moreover found that a better screw conveyor is produced than could otherwise be done. The screw was produced in the firm's ordinary centrifugal machines, which revolve horizontally. An idea of the excellent job done may be gathered from the accompanying photograph, which the firm has kindly sent us.

sand

How much of it goes into your cupola?

Sand in the desert may be appropriate enough, but sand in the cupola is nothing but a nuisance, requiring time and fuel to flux it, slowing down operations and adding considerably to [illegible] costs.

Workington and Distington Machine-Cast Hematite Irons are free from sand and include no unwieldy sows; they are 100% usable iron.

Workington & Distington Machine-Cast Hematite Irons

THE UNITED STEEL COMPANIES LTD

WORKINGTON IRON & STEEL COMPANY

Branch of The United Steel Companies Limited

WORKINGTON **CUMBERLAND**

Telephone: Workington 206 Telegrams: "Mosbay," Workington

(RB) W.53

The Week's News in Brief

Trade Talk

THE MINISTRY OF AIRCRAFT PRODUCTION has received a gift from the people of the Netherlands East Indies of 200 tons of aluminium.

FOUNDRY EQUIPMENT, LIMITED, Linsdale Works, Leighton Buzzard, have decided to pay weekly family allowances of 2s. 6d. for each child to their workpeople.

PETTERS, LIMITED, has re-opened its London office at Bush House, North West Wing, Aldwych, W.C.2. The new telephone number is Temple Bar 6262 (3 lines). Mr. A. P. Quarrell, A.M.I.Mech.E., is resuming his duties as London manager.

THE LONDON OFFICES of Brush Electrical Company, Limited, and of Brush Coachwork, Limited, have been moved from 88, Kingsway, to Bush House, North West Wing, Aldwych, London, W.C.2. The new telephone number is Temple Bar 6262 (3 lines).

A SCHEME has been devised by the Minister of Supply for the clearance of scrap iron and steel from bombed areas in the City and Greater London. Arrangements have been made with merchants to take delivery of the material as it becomes available.

THE COUNCIL of the Institution of Factory Managers is awarding the 1941 Sir Henry Fildes Medal for the best essays on "Factory Welfare." The copyright will remain the property of the Institution. The length should not exceed 5,000 words. The essays must be type-written, and a broad margin should be left. All entries should be submitted by registered post, before September 1, and should be addressed to the Secretary of the Institution, Mr. L. M. Angus-Butterworth, Ashton New Hall, Ashton-on-Mersey, Cheshire.

A CLEARING CENTRE has been established in Scotland to assist the war effort by ensuring that the fullest use is made of spare machine-tool capacity. Whenever spare capacity occurs in the load of individual machines because of unbalance of plant, irregular flow of orders, delay in receipt of materials, etc., employers are asked to notify the secretary of the Regional Board, Mr. W. R. Grist, 21, Glassford Street, Glasgow, so that steps may be taken to place the firms in touch with suitable work.

UNDER a Board of Trade Order which comes into force to-day, licences will be required to export certain additional manufactures of iron and steel, all kinds of mechanically-propelled road vehicles (including certain specified parts) and further types of electrical measuring instruments. The Order prohibits the export without licence of antimony oxides, and extends the existing prohibition in respect of jute manufactures, asphalt, bitumen and pitch. The additional iron and steel goods now scheduled are domestic stoves, grates, and baths and other similar foundry products, and domestic hollow-ware.

UNDER the Machinery, Plant and Appliances (Control) (No. 4) Order, 1941, just published, new classes of machinery, plant and appliances subject to licence by the Board of Trade are added to those listed in the schedules to previous Orders, and certain of the classes already included are amended. Further, it has been laid down that machinery, plant and appliances may be supplied without licence under the Orders to a public-utility undertaking when such supply can be made only with the licence or under the authority of a Government Department. The complete schedules are listed in the Order, which is obtainable, price 1d., from H.M. Stationery Office. Application forms for licences to acquire machinery, plant and appliances may be obtained from the Industrial Supplies Department (Machinery Licences Division), Board of Trade, 1-6, Tavistock Square, London, W.C.1.

COMMENTING, in a report just published, on the amount of absenteeism in two filling factories visited by a sub-committee, the Select Committee on National Expenditure states that the chief reasons seem to be transport difficulties over the long distances which the workers have to travel; absence of adequate accommodation near the factories; working conditions, particularly canteen arrangements; and the seven-day week. The sub-committee considers that these avoidable causes should be effectively dealt with at once, and then any residue of culpable absenteeism could be remedied by appropriate action. The sub-committee states that "the provision of special trains and omnibuses at the right times is essential, but adequate arrangements do not seem to have been made. It is unfair to expect workers to be punctual or regular in their attendance in such circumstances." The sub-committee recommends that it should be a primary duty of the Ministry of Supply to make arrangements for adequate transport facilities.

Obituary

MR. GEORGE MARTIN, general manager and secretary of the Davis Gas Stove Company, Limited, Luton, died at St. Albans on August 6.

THE DEATH has occurred of Mr. Arthur Graham Primrose, chairman of Dickson & Mann, Bathville Steel Works, Armadale. He was 57 years of age.

MR. THOMAS SMELLIE, a director of P. & W. Maclellan, Limited, Glasgow, died on August 4, aged 63. He was chairman of the Glasgow and District Iron and Steel Stockholders' Association.

MR. ALBERT CROSSLEY, works director of the English Steel Corporation, Limited, died at his home at Fulwood, Sheffield, last week. Mr. Crossley, who was 64, joined the engineering staff of the Sheffield Tramways Department, but on the outbreak of the last war took up an appointment with Thos. Firth & Sons. After the war he became manager of the Clayton Forge, Limited, Lincoln, returning to Sheffield eight years ago as works director of the English Steel Corporation.

MR. JOHN G. FAIRGRIEVE, assistant works manager at the Clydebridge Works of Colvilles, Limited, died at his home at Cambuslang on July 23, at a comparatively early age. Mr. Fairgrieve joined Colvilles, Limited, in 1919 as chief chemist, in succession to the late Mr. D. J. Pinkerton, and later was transferred to the melting department, where he was associated with the late Mr. Alec Reid, whom he succeeded as manager. Mr. Fairgrieve, who was assistant works manager for the past 12 years, was a member of the Iron and Steel Institute, and served on the Ingot Moulds Sub-Committee.

Personal

MR. P. W. WOOD, steelworks manager at the Consett Ironworks, has been appointed a magistrate for the Consett area.

MR. GERALD W. LACEY, who has been appointed to the post of Light Metal Controller by the Ministry of Aircraft Production, will be responsible for the control of aluminium, magnesium, silicon and light alloys. He succeeds the Hon. G. Cunliffe, who was Aluminium and Silicon Controller, and Mr. G. C. Usher, who held the post of Magnesium and Light Alloys Controller.

Reports and Dividends

Hadfields—Interim ordinary dividend of 7½% (same).

Head Wrightson—Final dividend of 3½%, making 6% (same).

Darwins—Ordinary dividend of 5% (nil) for the year to March 31 last.

George Kent—Trading profit to March 31, £100,684 (£53,373); net balance, £38,200 (£20,312); final ordinary dividend of 7%, plus 2½% bonus, making 12½% (increase of 3½%); forward, £40,530 (£40,812).

Aveling-Barford—Profit to March 31, after depreciation, pension and assurance schemes, A.R.P. and E.P.T., £74,694 (£117,396); tax, £41,500; net balance, £29,094; ordinary dividend of 10%, tax free (12½% net); forward, £40,270 (£35,961).

Broken Hill Proprietary—Net profit for the year ended May 31, £963,278, after providing £996,880 for depreciation, £1,050,000 for income-tax, and £456,330 for special depreciation of plant and machinery, etc.

Warner & Company—Trading profit for the year to June 30, £11,862 (£10,646); dividends on the 6% cumulative preference shares for the 18 months to December 31, 1940, £2,329; preference dividend for half year to June 30, £675; dividend on the ordinary shares of 5%, £1,000; forward, £3,541.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Bedford Metal Company, 24A, Friar Street, Reading, Berks—£1,000. E. A. Mellor.

Engineering Auxiliaries, Erwood, Gwenddwr, Brecon—£3,000. C. Hughes and R. L. Fox.

Park Foundry Company (Chesterfield)—£600. R. H. Pickles, 2, Highfield Road, Chesterfield.

Metropolitan Tool & Products—£1,000. N. W. A. Penn, 144, Copse Hill, London, S.W.20, subscriber.

J. Clark Engineering Company, 17, Finsbury Square, London, E.C.2—£6,000. S. Fass and A. W. Clark.

E. Tallis & Sons, 79-81, Lombard Street, Birmingham—Manufacturers of pressed steel moulding boxes, etc. £3,000.

H. W. Nock & Company—Engineers, etc. £4,000. H. W. Nock, Glen-haven, Wolverhampton Road East, Wolverhampton.

John Walton (Residues)—Metal smelters and workers, etc. £5,000. A. J. Luck, "Darley Dale," Takeley, Essex; S. W. Platt.

A. Fielding & Company (Keighley)—Engineers and tool makers. £5,000. A. and G. Fielding, 8, Ellton Grove, Wibsey, Bradford.

Thomas Sorby & Sons, Canal Steel Works, Lumley Street, Sheffield—Steel, iron and metal manufacturers. £500. A. H. Winston.

Morgan-Milnes Tool Company—£1,000. S. Carr, F. F. P. Milnes, and J. Morgan, "Ballin Ling," Healey House, Netherton, Huddersfield.

Precision Engineers (Woolacombe)—£2,000. R. B. Page and R. Tomsett. N. F. Zabell, 10, Upper Mulgrave Road, Cheam, Surrey, subscriber.

Willamot Products, Priory Bridge Road, Taunton, Som—Ironfounders, engineers, etc. £1,000. V. J. Keith, A. G. Wilson and C. W. Adcock.

W. J. Mariner & Company, 3-13, Crawley Road, Luton—Non-ferrous metal founders, engineers and metal merchants. £200. W. J. and J. A. Mariner.

North's Gears—Gearing manufacturers, pattern makers, engineers, etc. £1,000. A. E. and D. H. Ford, 41, Crawshaw Grove, Sheffield; M. A. and L. H. North.

Neelands, 4, Palladium Buildings, Eastbourne Road, Middlesbrough—Engineers, metal founders, etc. £1,500. T. Thompson, W. S. Gibson, J. Bowen, and R. M. Shields.

Victoria Foundries (Alton), 2 and 4, Tranton Road, Bermondsey, London, S.E.16—To take over a business carried on at Alton, Hants. £5,000. J. E. G. Maynard and R. E. Whiting.

Contracts Open

Ilkley, August 25—Supply and installation of filtration plant, for the Urban District Council. Mr. A. Skinner, water engineer, Town Hall, Ilkley.

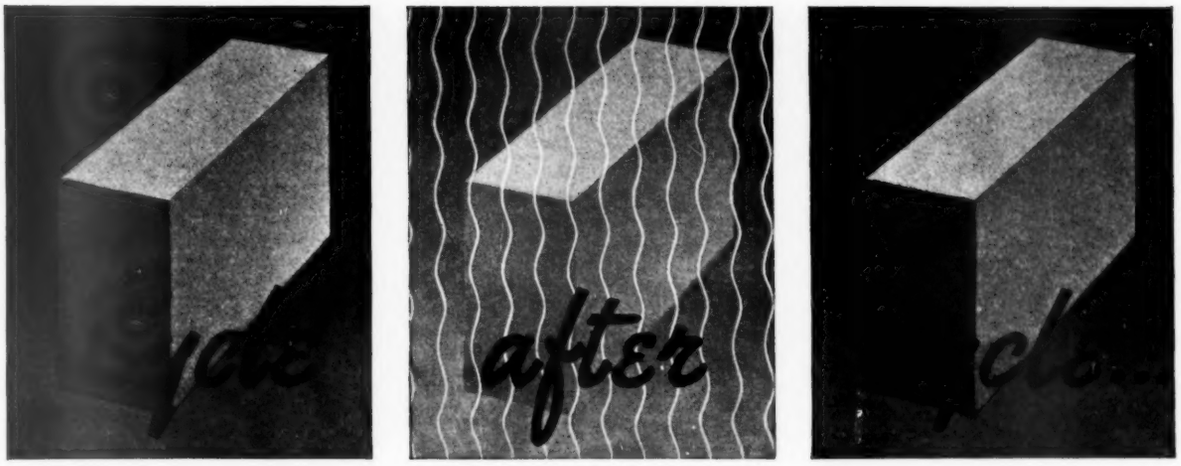
Rhyl, August 25—Supply and erection of 110-b.h.p. oil engine, for the Urban District Council. Mr. O. P. Cronshaw, water engineer, Paradise Street, Rhyl. (Fee £1 1s., returnable.)

Normanton, August 28—Laying of approx. 400 yds. of 4-in. cast-iron water mains, Class D, for the Urban District Council. The Surveyor, Council Offices, Normanton, Yorks. (Fee £2 2s., returnable.)

Beverley, August 18—Provision, laying and jointing of approx. 5,500 yds. of 3-in. and 5-in. spun-iron water mains, etc., for the Rural District Council. The Engineer, 36, Market Place, Beverley. (Fee £1 1s., returnable.)

Farnham, August 23—Laying of approx. 288 yds. of 12-in. hydraulic main, etc., alternative prices being given (*a*) using asbestos cement pipes, (*b*) cast-iron pipes, for the Urban District Council. Mr. L. H. Starling, engineer, Council Offices (Annexe), Farnham, Surrey.

Hay, August 26—Provision and installation of electric motor-driven pumping plant, comprising one centrifugal pump, electric motor and switchgear, the set to be capable of pumping water at the rate of 2,500 galls. per hr. against an overall static head of approx. 120 ft., for the Urban District Council. Mr. A. H. S. Walters, consulting engineer, Temple Row, Birmingham, 2. (Fee £2 2s., returnable.)



"G.R." FIREBRICKS which enjoy the confidence of leading engineers:

GLENBOIG SPECIAL:
For use in all types of combustion chambers & furnaces operating at high temperatures.

GLENBOIG SPECIAL CROWN:
For suspended arch blocks and all blocks subject to thermal shock and high temperatures.

GLENBOIG:
Unequalled for general furnace construction, boiler linings, baffles, etc.

GLENBOIG CROWN:
For suspended arch blocks, throat bricks—wherever freedom from spalling is the most important factor.

CASTLECARY:
General Furnace work, boiler linings, etc.

GEM:
All positions where conditions are less severe than those which necessitate the use of first grade Scottish Firebricks.

ADAMANTINE:
Hard vitrified firebricks highly resistant to abrasion—extensively used in cool end of re-heating furnaces.

LLANGENNECH:
For use in secondary positions. Good shape and size.

WHITE CARR:
A general purpose firebrick, especially suitable for ladle linings in steel works.

STOURBRIDGE:
Standard Stourbridge firebrick of excellent shape and size.

HIGH REFRACTORINESS *freedom from spalling*

THESE two important factors are provided for in the range of firebricks supplied by General Refractories. An exacting control of the raw materials available from its many firebrick works throughout the country—the use of the most modern equipment—the rigid application of laboratory tests at each manufacturing stage—these ensure a supply of sound firebricks of uniform quality, shape and size.

The resources of General Refractories enable them to offer a range of refractories suitable for the execution of any contract. The user may, therefore, depend upon receiving carefully considered and unprejudiced recommendations directed solely to ensure maximum life and dependability from his furnace structures.

GENERAL REFRACTORIES LTD.

HEAD OFFICE: GENEFAX HOUSE, SHEFFIELD, 10. TELEPHONE 31113 (6 LINES)

G.P.13

FIREBRICKS: *Glenboig Special, Glenboig Special Crown, Glenboig, Glenboig Crown, Castlecary, Dykehead, Gem, White Carr, Stour, Hycone, Alumantine, Hysilyn, Adamantine, Llangennech.*
BASIC BRICKS: *Spinella, Saxpyre, Supermag, Diazite, Dolomax.*
ACID-PROOF REFRACTORIES: *Obsidianite, Losol.*

INSULATION: *Amberlite* Bricks, Cement and Concrete.
SILICA BRICKS: *Lowood, Meltham, Allen, Quartex.*
CEMENTS: *Sintex, Durax, Pyrolyte.* PLASTICS: *Durax, Rotaline, Plastic K-N., Glendoline, Ground Ganister, Steel Moulders' Compositions.* SILLIMANITE: *Tank Blocks, Bricks and Cements.* SANDS: *Moulding, Brick Facing, Silica, Glass*

Raw Material Markets

Supplies of high-phosphorus pig-iron continue to be freely available and many consumers are taking advantage of the position to lay down stocks, which should be particularly valuable during the winter months. This type of iron in normal times is required mostly by makers of light castings, but, owing to the shortage of better qualities of iron, a fair amount of high-phosphorus material is being incorporated in the mixtures of the heavy engineering foundries, which remain very actively engaged on contracts of national importance. While business in iron and steel is subject to licensing arrangements of the Control authorities, the latter are usually willing to facilitate purchases in excess of current needs when this is practicable.

Pig-Iron

MIDDLESBROUGH—The output of Cleveland foundry iron continues to be negligible, so that users on the North-East Coast have still to make recourse to the Midland furnaces. Fortunately, supplies from Derbyshire and Northamptonshire are not subject to delay, and buyers are permitted to order iron in excess of their immediate requirements. Activity among the light-castings foundries is much below normal, but heavy engineering concerns are well booked ahead, while replacement orders are readily available.

For a long time past it has not been possible for users of hematite to secure all they require, and substitutes in the form of high-phosphorus and refined irons and scrap are being used extensively. Distribution of hematite is now confined to those consumers who are on urgent work and who cannot easily utilise other grades of iron. Supplies of imported hematite and low-phosphorus iron are still on hand, but these are being released only sparingly by the Control.

LANCASHIRE—Ordinary qualities of foundry iron are in only moderate demand, due to quiet conditions among jobbing and light-castings foundries and textile-machinery manufacturers. Heavy engineers, on the other hand, are very busily employed, and consumption of iron at these foundries is high. It is expected that there will continue to be a plethora of contracts handed out to makers of heavy castings, who are able to satisfy important Government needs. Hematite is not coming through as freely as might be desired, and the demand for special refined grades of pig-iron is, consequently, substantial.

MIDLANDS—In this part of the country demand for low-phosphorus iron and hematite is maintained at a high level and current deliveries are not sufficient to meet all demands. To overcome this handicap, however, consumers have in many instances been able to utilise high-phosphorus iron in their mixtures; this iron is produced from home ores and is comparatively plentiful. Refined iron and steel scrap are also being taken up quite freely to eke out supplies of the special grades of iron. Heavy engineering works, together with a number of jobbing foundries, are fully occupied on orders for the various departments of the Government and on other work closely associated with the war effort. In direct contrast is the position of the light-castings trade, which is unable to operate to capacity; only a very small amount of Government work can be carried out in this section, while normal peacetime outlets have either vanished or been reduced to a low ebb. Works, however, are still buying moderate tonnages of high-phosphorus iron against licences, and many users have accumulated quite substantial stocks.

SCOTLAND—All important users of pig-iron are getting their full requirements met without delay, but deliveries in other directions are inclined to be slow. Foundries producing heavy castings have as much Government work on hand as they can tackle, but the situation in the light-castings industry shows no indication of improving. Production of light castings is restricted, as the demand from the usual sources is much less than in normal times. Makers are receiving adequate tonnages of iron from the English Midlands, which has been the source of supply for some time past as a result of the virtual cessation of manufacture of this type of iron in the Cleveland district, which in peacetime was able to meet all the needs of the Scottish foundries.

Coke

Deliveries of foundry coke are very satisfactory and ovens are generally in a position to despatch extra supplies for stocking purposes. For delivery to Birmingham and Black Country stations, the current quotation of Durham best foundry coke is 62s. 9d. per ton; it is expected that this figure will be raised shortly, although no intimation of any change has so far been forthcoming from the Control authorities.

Steel

The steel industry has now been brought within the provisions of the Essential Work Order, and it has been announced that in some sections production will be expanded, while in others outputs will be curtailed. The fact that certain producing units can now be closed down is a tribute to the policy pursued by the authorities during the war to control the supply of raw materials and to restrict non-essential consumption. Holidays have generally now been disposed of and producing works are again concentrating on raising large outputs required for the satisfaction of Government contracts. Structural engineers are much more quietly employed than they were, with the result that the call for structural steel is reduced, but it is likely that further orders will soon be placed in this section by Government departments. Shipbuilders and boiler and tank makers are making heavy demands on the steel industry, while sheet makers have quite a substantial amount of urgent work still on hand.

Scrap

It was announced in the House of Commons on Thursday last that it was still necessary to import certain quantities of steel scrap, but that the recovery of scrap from buildings damaged by enemy action had been expedited and had enabled imports to be substantially reduced. Current deliveries of scrap to consuming works are much improved, but the call from the steel industry is fully maintained and most steelworks continued to accept delivery during the period they were closed for holidays.

Metals

COPPER—The satisfactory arrival of copper in the United Kingdom is due to a large extent to the progress which, with American co-operation, we have made in the Battle of the Atlantic; essential consuming plants are being supplied with adequate tonnages, but distribution in other directions continues to be very carefully controlled. In the United States, the regimentation of the copper industry has been completed by the Office of Production Management. While there is no metal to spare for ordinary domestic purposes, it is thought that the recent move by the O.P.M. will ensure a more satisfactory supply to works engaged on important contracts. A maximum price of 12 cents per lb. has been officially announced.

TIN—The date of the next meeting of the International Tin Committee is still undecided, as only a limited number of countries signatory to the restriction agreement have replied, although it is understood that most of the countries participating are in favour of the continuance of the agreement. Communication difficulties have caused a large number of the replies to be sent by mail. Japan's occupation of French Indo-China and the political position of Thailand adds to the postal delay. Thailand's continued adhesion to the scheme is important; her standard tonnage is 18,000 tons and last year her output was 17,447 tons out of 208,800 tons produced by all the signatory countries. For some time past Japan has been pressing Thailand to sell all her tin direct to Tokyo, and so ignore the international pact. The Netherlands Prime Minister has made it quite clear that, although the Netherlands have no diplomatic relations with the Soviet Government, the tin and other commodities of the kingdom of the Netherlands will contribute to the support of Russia.

According to the tin statistics compiled by Mr. W. H. Gartsen (Henry Rogers, Sons & Company), the total visible supply of tin on July 31 was 35,154 tons, against 33,545 tons at the end of the previous month. The carry-over in the Straits Settlements was 3,430 (3,095) tons, and at principal European smelters 3,004 (2,351) tons. Deliveries in July amounted to 15,922 tons, compared with 17,044 tons in June.

The Statistical Bulletin of the Tin Research Institute, Fraser Road, Greenford, Middlesex, reveals that world production of tin in June is estimated at 29,400 tons, compared with 22,900 tons in May. Production for the first six months was 127,400 tons, against 105,200 tons in the corresponding period of last year. United States deliveries totalled 14,880 tons in June, against 10,490 tons in May. U.S. deliveries in the first six months of 1941 were 80,372 tons, compared with 50,609 tons in the corresponding period of 1940. Tin consumption of the United Kingdom was 2,426 tons in June, against 2,501 tons in May and 2,784 tons in June, 1940. World stocks of tin, including smelters' stocks and carry-over, decreased by 1,165 tons during June to 55,975 tons at the end of the month. Stocks at the end of June, 1940, were 41,211 tons.

"The entanglements of Government red tape" was one of the main reasons for Malaya's present under-production of tin, said Mr. A. A. Henggeler, chairman of Larut Tin Fields, at the annual meeting at Kuala Lumpur. If the present policy of the Government in Malaya was not drastically changed, the position would deteriorate further, he added. Mr. Henggeler criticised the Government for the War Risk Insurance Enactment which came into operation on April 1 last, and said that a rate of 20 cents per picul had been fixed on tin ore and was payable by the producer. Producers considered that this rate was far too high compared with that ruling at home, taking into account the relative risks and period of cover and bearing in mind that tin ore was comparatively indestructible. The mining industry, he said, was not represented on the committee which sat in Singapore to frame the War Risk Insurance Enactment. Mr. Henggeler said that full-out production for the remainder of the year could be expected as the result of a new agreement for the six months ending December 31 whereby the United States Government had contracted to buy 37,000 tons of tin at 50 cents. During the year the Larut Tin Fields concern had secured a new property through Anglo-Malayan Development, which would make a difference to the life of the mining property as a whole.

Tin prices on the London Metal Exchange during the past week have been as follow:—

Cash—Thursday, £256 10s. to £256 15s.; Friday, £256 10s. to £256 15s.; Monday, £257 to £257 5s.; Tuesday, £258 to £258 5s.; Wednesday, £258 15s. to £259.

Three Months—Thursday, £259 15s. to £260 5s.; Friday, £259 15s. to £260; Monday, £259 15s. to £260 5s.; Tuesday, £260 5s. to £260 10s.; Wednesday, £260 15s. to £261.

SPELTER—Demand for spelter keeps up to a high level, and the supply position, on the whole, is satisfactory, although allocations of the metal are largely restricted to consumers employed on orders for Government departments. Fairly large quantities of American zinc have arrived at United Kingdom ports recently, and have contributed to the maintenance of a regular flow of deliveries to working-up industries. Progress is also being made in the efforts to expand home domestic production. According to advices from the United States, spelter requirements—military and civilian—during the current year will amount to about 1,650,000 short tons. Available supplies, however, are not expected to be more than between 890,000 and 950,000 tons. The chief difficulty in the American situation is that of shipping the necessary ore concentrates.

LEAD—It has been the wartime policy of the Canadian authorities to despatch to Britain practically all the surplus lead supplies in the Dominion after home needs have been met. Thus, it will be interesting to note the effect on these shipments by the recent orders for lead placed by the American Metals Reserve Company with Canadian producers. As yet, the lead supply situation here is quite satisfactory. The position in the United States tends to tighten still further, and, according to the American Bureau of Metal Statistics, producers' stocks of refined and antimonial lead were down to 24,300 short tons on June 30, against 34,018 tons at the end of May. Output in June was 48,200 tons, or 12,300 tons below the production in the previous month. Deliveries in June also were lower at 58,000 (69,400) tons.